

Aviation Week & Space Technology

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The Vital Recess of this Meeting - HI-TORQUE® by Voi-Shan

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Head and power drivers are readily available from Voi-Shan. The Hi Torque recess can be applied to all standards including the difficult to work Reflectorites. Hi Torque is available in diameters from 1/4" thru 2" in both standard and head styles. No less R&M standards, plus specials and the superior self locking combination, Hi Torque with Lock Screws are available from stock. For detailed information on this and other Voi-Shan quality products write on your letterhead to:

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University surveys indicate:

STARTING SALARIES OF ENGINEERS ARE DECEPTIVELY HIGH

By James M. Jenks



TWO SEPARATE STUDIES of the salaries made by college graduates appear to contradict the commonly held belief that engineers today make out better financially than their classmates who major in non-technical subjects.

Both surveys were conducted by large universities. The first polled graduate engineers, the second, company executives. And both resulted in identical findings: That is, the average engineer today—despite a deceptively high starting salary—chocks out but not far.

The need for technically trained men in recent years has exceeded the supply to such an extent that companies have been forced to bid for their services—to actually set-up "recruiting" offices on college campuses all over the country. Thus, starting salaries have gone up and up. But the income ceiling for these technically-trained men is lower than that for managerial personnel.

Despite the substantial head start engineers have, the differential in money earned over a ten-year period averages out at \$7,000 more for the management man.

And from the tenth year on, the administrator's salary obviously outstrips that of the engineer by a wider and wider margin.

This, of course, is not to say that engineering students would be wise to shift to the study of business administration—or that working engineers face a bleak future. Quite to the contrary, the continuing growth of technology means that men with technical backgrounds are as ideally qualified for the highest rewards industry has

to offer—if they also have a knowledge of the underlying principles of business.

FREE—"FORGING AHEAD IN BUSINESS"

If you want to avoid the thorny barriers to success—if you're ambitious, determined to move up fast—send today for the Institute's 46-page descriptive booklet, "Forging Ahead in Business".

It explains what a man must know today to make \$25,000 or more a year—what he must do to accelerate this knowledge. It tells why men of equal ability have so differently as the race for better jobs and bigger salaries. It explains the reasons of failure—the reasons for success. And it outlines an *exclusive* training program which is so complete and so scientific that such day scholars are brought a little closer to a mastery of business procedures.

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VENUS CALLING: MESSAGE 1

Marsner II, the nation's most sophisticated deep space probe, will give us our first close look at Venus. Yet, the signal from Marsner II will be only 0.1 microwatts when it reaches the big dish antenna at Goldstone, Calif.

Tiny signals of this magnitude will be amplified by the new MEC master which Jet Propulsion Laboratory will install on the antenna. The traveling wave master designed for field operation operates in a closed cycle regenerative and provides 36 db gain at 5 band at a temperature of 43° K. Operationally designed and developed by our R & D department, the MEC master is available on the open market with this combination of features.

Other MEC masters offering up to 30 db gain over a 100 Mc bandwidth and a 16 Mc instantaneous bandwidth are available for L, C, and X band operation.

If you have problems involving sophisticated microwave devices demanding capability in master techniques, magnetic resonance, cryogenics, special purpose metal-ceramic traveling wave tubes, perhaps we can be of assistance.



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AEROSPACE CALENDAR

(Continued from page 7)

- Apr. 17-18—Southwestern Conference and Electronic Show, Institute of Electrical and Electronic Engineers, Dallas, Texas. Sheraton Hotel, Dallas, Tex.
- Apr. 27-29—Technical Meeting, Nuclear Materials for Space Applications, American Nuclear Society, Cumberland House Hotel, Cincinnati, Ohio.
- Apr. 21-23—Annual Meeting, National Association, Service, Austin, Working for D. C.
- Apr. 22-24—Annual Meeting, Space Flight Symposium, Institute of the Aerospace Sciences in cooperation with NASA and AFSC, Dallas, Tex.
- Apr. 21-24—Third Annual San Diego Symposium for Aerospace Engineering, Del Webb's Oceanfront, San Diego, Calif.
- Apr. 24-26—Fourth Region Technical Conference, Institute of Electrical and Electronics Engineers, San Diego, Calif.
- Apr. 29-May 2—22nd Annual National Conference, Society of Automotive Engineers, Sheraton-Hilton Hotel, St. Louis, Mo.
- Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Sheraton-Hilton Hotel, Houston, Tex. N. J. Corporate Army Research Office.
- May 13-15—19th Annual National Forum, Southern Hemisphere Society, Sheraton Park Hotel, Washington, D. C.
- May 2—Electronic Conference, American Radar Society and Aerospace Medical Assn., Los Angeles, Calif.
- May 23—Fourth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, Maxwell-Titan Ridge Hotel, Washington, D. C.
- May 24-26—1961 Annual Conference, American Assn. of Airport Executives, Gulfstream Villa, Beach Club and Golf, Fort Lauderdale, Fla.
- May 24—Aerospace Reliability and Maintainability Meeting, Institute of the Aerospace Sciences, Washington, D. C.
- May 18—Electronic Components Conference, Institute of Electrical and Electronics Engineers, Maxwell-Titan Ridge Hotel, Washington, D. C.
- May 11-13—National Aerospace Electronics Conference, Institute of Electrical and Electronics Engineers, Sheraton-Hilton Hotel, Denver, Colo.
- May 11-17—Congressional General Flight Forum's Second Annual Symposium on Air Transportation, Bartlett, Conn.
- May 12-13—National Symposium on Micro-wave Theory and Techniques, Institute of Electrical and Electronics Engineers, Maxwell Hotel, Santa Monica, Calif.
- May 20-21—National Telecommunications Conference, Hilton Hotel, Albuquerque, N. M.
- May 21-23—Spring Joint Computer Conference, Association of Professional Information Processing Societies, Cobo Hall, Detroit, Mich.
- May 27-28—Seventh National Conference on Fusion Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.
- June 7-16—1961 French International Air Show, Le Bourget, Paris, France.



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Check with Janitrol the next time you want an oil cooler or heat exchanger. The biggest reason is reliability. The ability to produce production units with the same high quality of the prototype begins with our ability to form flat-plate sheets of stainless steel, titanium and aluminum. We use new techniques for creating optimum heat transfer surfaces and structural strength in a wide variety of ways. We make heat exchangers and heat transfer systems for liquid/liquid, liquid/gas, and gas/air for both high temperature and cryogenic applications.

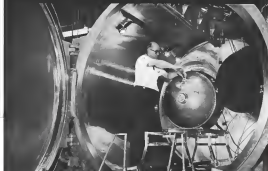
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"WORKHORSE" FOR GODDARD'S ENVIRONMENTAL TESTING



The 378 cubic ft. Atmospheric Simulators (150 ft. x 54 ft. x 6 ft.) facilities (top) provide an ambient space environment testing in the Subzero/Vacuum and Simulated Earthquake "Wing 21."

The Goddard "6 by 8" (6 ft. in diameter and 8 ft. long) horizontal test chamber is one of the key elements in the spacecraft testing program at NASA's Goddard Space Flight Center, Greenbelt, Maryland.

This Stokes-designed and Stokes-built thermal-vacuum test was the first large space simulation facility installed at Goddard for testing unmanned vehicles under the full range of thermal and vacuum conditions, and is the largest presently in use there. It has a vacuum capability of 1×10^{-7} Torr (290-mile altitude) under full load conditions, and is equipped with a heat transfer system capable of handling radiant wall temperatures from -65°C to 100°C .

Goddard's "6 by 8" will continue to serve in the Space Flight Center's highly successful reliability testing program until the larger test and evaluation laboratories now under construction go into service early in 1963. Major space test chambers of this facility, which is expected to set the most advanced standards for spacecraft check-out, are two 30 ft. diameter, 60 ft. high thermal-vacuum environment simulators. Stokes was selected as the prime contractor to NASA for complete vacuum and cryogenic systems for these large chambers.

We welcome your inquiries regarding our capabilities and facilities for designing, fabricating, and erecting simulation facilities well in advance of the state-of-the-art, or any portion of a simulation project requiring high-vacuum and cryogenic systems. Space Systems Department, P. J. Stokes Corporation, 3380 Fisher Road, Philadelphia 26, Pa.

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Out and Back. USAF's X-36 Dye-6000 will be captured on re-entry and precisely guided to touchdown by a Sperry microwave aerospace terminal control system. NASA's moon-bound Apollo will receive continuous on-course data through tiny Sperry control devices, part of the MIT-designed guidance sub-system. Also for NASA, Sperry is studying which jobs man and instruments can do best in space-launch vehicles, supplying long-life spectrometers for satellites to measure the gaseous composition of space. A Lunar Navigation Grid System—lunar surface-sampling and return systems—laser-Doppler space rendezvous radar—interplanetary navigation spacecraft stabilization and control—are a few longer-ranged Sperry studies. Sperry scientific, management and production skills are tested for space. General Office: Great Neck, N.Y.

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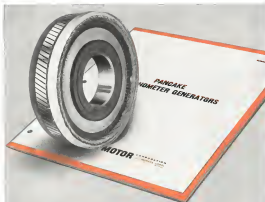
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NEW HARTFORD, NEW YORK

*UDIMET 700 developed by SPECIAL METALS in 1951.



Six reasons why servo designers specify INLAND D-C TACH GENERATORS for both rate and position control systems

There are more than 6 reasons! In fact, you'll find 12 pages of data in the new Bulletin 201, just off the press. Your copy is waiting for your name and address. Meanwhile, let's look at 6 of the reasons why designers specify Inland Pancake D-C Tachometer Generators.

- 1 High resolution!** Feedback from a direct driven tach generator allows accurate system stability because it eliminates gear backlash and friction.
- 2 Rapid response!** Time constants of less than .001 second are possible even when each output is filtered.
- 3 Low ripple voltage** is inherent in Inland Tach Generator design. A special seal has even been made with ripple voltage as low as 0.1% at a base frequency of 300 times motor speed.
- 4 High sensitivity!** Inland Tach Generators are now serving in rate feedback for rates as slow as one revolution per year.
- 5 Pancake configuration!** Models with solid thicknesses ranging from 0.305" to 1.5" in OD's from 1.927" to 12.75" and weights from 0.30 to 40 pounds meet close weight and space limitations. The compact design, common to both Inland Tach Generators and Pancakes, allows their integration in space saving Tach-Force units for servo loops.
- 6 Long operational life!** 1-4: their torque motor counterparts, Inland Tach Generators deliver up to 10,000,000 revolutions with low-gate wire brushes. 1-4: more than 180,000,000 with silver graphite brushes.

Get all the facts about Inland Pancake D-C Tachometer Generators. Write for Bulletin 201 today!



INLAND MOTOR

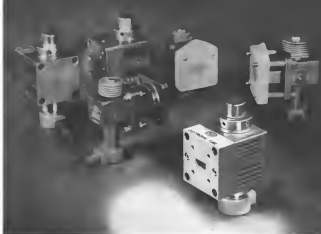
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THE FLEXIBLE MEN Never has man faced so formidable a combination of unknowns as in the exploration of space. It is a challenge that demands investigation along the entire spectrum of the scientific disciplines; it represents a compendium of scientific thought that is being revised and refined hour by hour... by men of widely diverse scientific backgrounds.

And out of the interplay among all the disciplines represented, a new breed of scientific men is emerging. They are men of curiously intermixed scientific talents. Men with an insatiable curiosity—not only in their own field, but in others. They are cross-pollinators of ideas. The outsiders of research and invention. They are a catalytic force that is making today's aerospace industry the most dynamic in the history of mankind. They are the flexible men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.



New 50V-5280 pump pumps and measures at 15 Gc and delivers 500 mW of power. Operation at any frequency from 11 to 40 Gc is possible with this new oscillator family. Although miniaturized these Sperry oscillators have the frequency, high power, and reliability of heavy-weight tubes.

New miniature, high-power oscillators push range to 40 Gc for paramp pumping

A new family of V band two-cavity klystron oscillators provides high power levels for parametric amplifier and pump pumping, doppler systems, and FM communication systems. These tubes cover the frequency range from 31 to 40 Gc. You now get officially in 60-day delivery of two-cavity oscillators from Sperry Electronic Tube Division at any frequency from 12.5 to 40 Gc.

The unique combination of 500 mW power output at frequencies up to 40 Gc, exceptional AM stability, and small size is found only in Sperry's two-cavity design.

These Sperry miniaturized pump tubes weigh just 12 ounces—yet offer the performance formerly found only in much larger, heavier tubes.

The flame-tipped "output power vs. beam voltage" mode shape results in outstanding amplitude stability, zero variation in beam voltage and temperature produce only negligible variations in output power.

Sperry's two-cavity oscillators deliver power outputs ranging from .5 to 2 watts. Typical output at U band is 2 watts and at V band, 500 mW.

Use of two-cavity klystrons also permits considerable

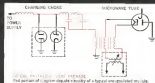
system simplification, since equipment such as reference power supply, automatic power leveler, and—in most applications—automatic frequency control can be eliminated.

For applications where outputs up to 500 mW and wide tuning ranges are required, ask about Sperry's tunable, low voltage reflex klystron pumps.

A free technical booklet describing the entire Sperry line of pump and pump tubes—both two-cavity and reflex—is now available. For your copy, write Sperry, Box 166, Gainesville, Florida, or contact Chan & Co., Sperry's national representatives.



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"Pulse packages" may change radar design techniques

The Bayesian "pulse package" is a modular model such as a pulse transformer and pulse forming network designed and built to precisely match a specific microwave tube.

Final design of each unit is arrived at only after thorough testing and loading of both transformer and PIN while operating with the specific microwave tube type. This assures better pulse shape as well as greater stability and reliability.

Now, rather than specifying components,

individually, you specify the modulator module for the specific microwave tube type. You may then be assured of equipment-to-equipment compatibility and high system performance.

Write for details: Raytheon Company,
Microwave and Power Tube Division,
Waltham 54, Massachusetts



Aviation Week & Space Technology

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MESSAGE FROM THE PUBLISHER
Outlook for 1963 21

COVER U.S. Navy (architect: Polaris A2) intermediate-range ballistic missile is launched first test at Cape Canaveral, Fla. Improvements in the A3 include a reduction in the guidance package volume and weight to afford that of the A1 and A2 versions, multifactor control by means of gaseous mercuries on the first stage and fuel injection in the second stage, glass filament-wound motor casings on both stages, and a larger amount of a hydrogen-peroxide fueled propellant (AW No. 15 p. 20). Design range is 2,500 mi., but this may be traded off for a lower weight.

FIGURE CREDITS
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Outlook for 1963

The aerospace industry can look forward to record business in 1963 with sales forecast to edge over \$16 billion. At the same time it will face acute problems in handling its principal government customers and keeping pace with a galloping technology that will challenge its technical resources and management capabilities.

Space will continue to be the key to this expanding market in 1963. Total space budget for Fiscal 1964 will top \$7 billion with National Aeronautics and Space Administration accounting for from \$3.5 to \$6 billion and military space another \$1.5 billion. Defense budget will increase from last year's \$51 billion, with aircraft and helicopter development making a comeback and the missile market holding strong. Air transport is climbing fast out of its usual jet age downturn problems and appears headed for a period of profit for airline management that have solved the jet age problems. Then with flying will enter the jet age during 1963 and ease back its health problems.

For *Aviation Week & Space Technology* this year will also pose a challenge to continue its expansion and division to meet the complex technical and management needs of this ever changing industry which it serves.

In 1962 *Aviation Week & Space Technology* capped a decade of leadership in this field and for the last two-year period (1958-61) opened the widest margins in our history, over competition in editorial excellence, art and circulation of international scope and advertising volume.

Advertising, Circulation Lead

During 1962, *Aviation Week & Space Technology* with a net paid circulation of approximately 81,300 and 4,810 advertising pages led its closest competitor, *Space Aeronautics* by approximately 35,000 copies in circulation and 2,064 pages of advertising*. *Aviation Week & Space Technology* passed 81 pages over 1961 while *Space Aeronautics* was 217 pages below its 1961 total. *Aviation Week & Space Technology's* margin over the third magazine in the field, *Mission and Reaction*, was approximately 40,000 in circulation and 2,825 pages of ads. The net ad publications in the field amounted for a combined total of 2,573 pages of advertising. As an indication of vitality in attracting the advertising assets of the ever-developing aerospace technology, \$13 new advertising accounts appeared in *Aviation Week & Space Technology* during 1962.

* All statistics compiled by Research Department, *Aviation Week & Space Technology*. Circulation figures quoted are according to available published information.

The editorial staff expanded its space technology team during 1962 to follow the mushroom growth of this field and established a full time staff bureau at Cape Canaveral. The special NASA edition, "Specialized to Space," published last July 2, was generally recognized as the latest job done to date in this vital area and attracted the largest advertising revenue for a single issue in our history.

International scope of editorial coverage continued to increase in 1962 ranging from the technical aspects of the Sino-Russian war, Cuban missile crisis, and joint European production program for the Lockheed F104G Starfighter to outstanding technical developments in England, France, Germany, Italy and the Soviet bloc. The European editorial staff will be expanded further in 1963 to match the growing importance of this area in the international aerospace market.

New editorial services were offered the airline industry with publication of special operational and financial statistics and an International Air Transport issue distributed at the International Air Transport Association general meeting in Dublin last September.

Continuing Expansion

To meet the increasing demand for *Aviation Week & Space Technology* from its international technical, military, government and management personnel we will expand net paid circulation to approximately 90,000 by the end of 1963. During last year, this magazine's air freight delivery service was expanded to service 15 European countries providing delivery equivalent to domestic subscribers.

Aviation Week & Space Technology's publishing philosophy has always been to do whatever is necessary to provide the industry at large with the vital technical, economic and political data it requires at fast and accurate rates in a humanly possible. It has been a cardinal principle that this information must reach our subscribers fast enough to enable them to utilize it effectively in their work. With the help of all facilities of the McGraw-Hill Publishing Co., we are constantly exploring new methods of improving this service.

The response of the aerospace industry to the publishing philosophy and performance of *Aviation Week & Space Technology* during the past decade has been extremely gratifying to the editorial, sales, circulation and production team responsible for its worthy publication. The overwhelming evidence of that response during 1962 has made it possible to plan and execute expansion and improvement plans for 1963 and future years.

—Robert W. Martin, Jr.



No one believed us!

Sometimes a rainbow surprises a whale!

No one thought our small d.c. motors could do all we claimed. So we gave them away for trial.

We were the only people not surprised when our motors performed exactly as claimed.

The problem was the inherent inaccuracy of a conventional governed motor that couldn't be adjusted in flight. Had to be

grounded and re-calibrated quite frequently! Was bulky! Heavy!

We fished around, and came up with a whole of a chronometric motor. It was half the size and weight! Adjustable if necessary! Needed little or no maintenance. Did everything the larger motor did—and better! Usual? Not at The A. W. Haydon Company!

Our only concern is with time—and timing devices. We're confident of

every product we make. We take pride in giving others the same confidence in us—and in our products.

Do you have a time problem?

We have a timely solution!

AWHAYDON
COMPANY
DESIGNER IN ELECTRIC INSTRUMENTS AND CONTROL

McNamara Pushing USAF-Army Rivalry

Assignment of limited warfare missions at stake; role of helicopters in Vietnam stirs controversy.

By Larry Booda

Washington—Office of the Secretary of Defense is encouraging a strong rivalry between Air Force and Army in an increasingly role and mission struggle over who will provide close support, battlefield transport and reconnaissance and special warfare training.

Technique of allowing two or more military services to compete freely for a mission has rarely been used by Defense Secretary Robert S. McNamara since he took office in January, 1961. But in this case, he has let his advocates believe the rivalry will produce satisfactory equipment and tactics at relatively low cost.

The outcome involved are relatively unexplored. The rivalry that produces the most efficient and economical system will win the mission.

Latest move in the growing competition came last week from the Air Force, which announced that it has been authorized to receive personnel assigned to its Special Air Warfare Center at Eglin AFB, Fla., from 1,000 to 1,800. The center is composed of the First Air Commando Group and the First Combat Applications Group.

At the same time, the Army found itself having to defend against reports that a number of helicopters had been lost in a Viet Cong ambush last week (Jan. 5 in Viet Cong ambush, 15 in southeast of Saigon). Actually, only one helicopter was completely destroyed. In the rest of operations involving Jan. 5, the total was 11 (AW Jan. 5, p. 27). More than 10,000 men were there during that period.

The strong service rivalry was reflected in official statements, background findings and informal propa-

ganda comparing Air Force knowledge of close support aircraft with Army's mixed helicopter force.

Most of the pointed remarks at Eglin will be funneled into the Air Commando, whose special strength will range from five to six. The first mission was trained to attack and defend in all phases of airborne operations, including personnel and cargo delivery, close air support and reconnaissance.

Some of the mission, however, will go to the Combat Applications Group, whose mission is the development of aerial and associated equipment to be used in counter-offensive actions. It has been responsible for numerous designs of the Douglas B-26 and North American T-28 aircraft now being used in South Vietnam.

The role of free-fall weapons in South Vietnam was granted last week by the Air Force Secretary Eugene M. Zuckert, who recently returned from a 10-day tour in Vietnam. Zuckert said Air Force free-fall operations are essential in providing cover for Army helicopters.

Asked whether he thought that Army's helicopters could do the job, he said they were unsatisfactory.

The exchange of roles in Vietnam was one of the key elements, in which Army helicopters were assigned South Vietnamese troops in four teams, each made up of 10 Viet Cong helicopters.

The first were moved the area and unloaded without incident. General G. Delaney the second and third waves for about an hour and a half. When they moved, there was no ground fire and no casualties with the enemy.

Third mission later, tonight was made, and the fourth wave was loaded in a main body. This drew heavy fire from unengaged troops in nearby woods. Every helicopter in the wave was hit, but all of them are still flying.

During this action, five second Bell UH-1 helicopters struck the area where

the Viet Cong troops were located. In attempting to rescue the crew of the grounded CH-21, a second CH-21 was hit and could not be off. A UH-1 lost a nose blade and crashed, injuring the pilot and killing a crew member. A third CH-21 was damaged but was able to return to a secure area. The last CH-21 was being spun when one of two days. Only the UH-1 was a total loss.

Allen B. D. Felt, commander-in-chief, Pacific, arrived in South Vietnam Jan. 9 for conference with Gen. Paul H. Hays, commander of the U.S. Military Advisory and Assistance Group, probably to discuss reported serious recent delays.

Felt said "I question some of the things I have said. I understand it is a South Vietnamese victory." Hays said "I can tell you that it was."

Reports that Vietnam's military is required order to attack and that the fall of U.S. advances was high but led to increased demands for an investigation. Sen. John C. Stennis (R-Ten.) questioned the role of U.S. troops in South Vietnam, saying that it is a question of winning the war there. This brought a charge of "passionate definition aimed at disturbing public opinion" from the Saigon newspaper *Da Nang*. There have been 167 U.S. Army casualties since Jan. 1, 1962 of which 15

U.S. Men Flyby

Washington—More U.S. planes, flying over a Mass. flyby mission in late 1961 in the role of a reconnaissance and reconnaissance aircraft, are to be used to stop the operations of a Viet Cong unit, only that was.

NASA has had 101 F-4 Phantom II fighters in combat in the past year. In 1961 and 1962, reconnaissance missions in a Viet Cong flyby in mid-1961. Operations have been in the past. Operations have been in the past. Operations have been in the past.

General to stop a 1964 Vietnam mission was recommended by Felt because of the fact that it was obtained from the Marine 2 flight (AW Jan. 5, p. 31). NASA and Viet Cong that it will release this data as a Washington conference in mid-February.

It is expected that a Mass. period will be designed to make the area into a military area of study and to develop the Vietnam atmosphere for its field and transport.

The two Air Force B-26s were destroyed from the 1964 Vietnam period probably will be made available to the Ranger force expedition program.



PHOTO: A Viet Cong soldier in a field, looking towards the camera. In the background, there are some trees and a small structure.

were killed, 82 wounded, three captured and later released and one missing and later returned.

The Army believes that eventually there will be success in South Vietnam, but that it is a long-term action. The French left the country without a turned out as a huge. Communalism and noncommunalism have had little time to pass experience and equal costs.

The Army's use of armed helicopters (AW Dec. 24, p. 15) for close support is being accelerated. Clouds from the Directorate of Research and Development of the Advanced Research Projects Agency are evaluating this concept under the direction of Robert C. Phelps. The close support role is played only in UH-1s.

The operations of the two services to fulfill the limited role and counter emergency missions have been.

At the 1955 Air Force demonstrated that its light, fast, maneuverable and landing aircraft for battlefield support would be phased out. The job of battlefield troop transport and combat support would go to the more powerful aircraft. Some helicopters would be used for action against troops, employment and training for ground battlefield support, large STOL aircraft would transport troops and personnel reconnaissance.

At the 1955 Air Force, during the 1950s, the Air Force joined its procurement program on the concept that aerial support would be used from the concept of a kind of fighting. Highly sophisticated jet fighters were designed to fulfill this role. Delivery of conventional weapons was assumed. Reconnaissance was performed by jet fighters. Helicopter transport was performed by aircraft which required relatively long runways.

The Kennedy Administration made a key decision only in its estimate that the role would not necessarily bring with it the role of nuclear weapons, and encouraged the Army—only was at

made sense in developing closer battlefield support and tactics—to continue and expand its activities.

In the process, the program of the 1950. Key West role and mission agreement was signed and the Army went beyond its aircraft weight limits two and even began to evaluate tactical helicopters as its own.

Early in 1961, McNamara indicated that Air Force and Army would have to pay more attention to developing a period delivery of nuclear weapons in less than 1000 miles. Air Force was already trying to fill what it perceived a vacuum created by Air Force support.

Potter Buys Morane

Paris—Embroiderers Henry Potter has taken over the bankrupt private aircraft company Morane-Saulnier (AW Dec. 24, p. 15).

Several French companies, including Sud Aviation and the French civil aviation, had been merged into the control of Morane. Due to a company's financial problems, the firm was involved in liquidation.

Potter aimed to continue production of Morane-Saulnier's successful sports plane, the M-16, in 1961. The company was in a state of financial crisis. Potter aimed to continue production of Morane-Saulnier's successful sports plane, the M-16, in 1961.

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Potter, which jointly owns a company in France with Aero-Com, is likely to replace Continental powerplants for only being modified in Morane Potter sports plane with Kermec engine.

In April, 1961, the Air Force found its first commando unit, operating at the 4400th Combat Crew Training Squadron.

It was patterned after air commando groups which operated in the Chinese-Burma border during World War II.

Last April, McNamara wrote to then Secretary of the Air Force, Earl F. Bess, Jr., asking him to form a group to study tactical air mobility, emphasizing that conventional operations should be used. This resulted in the formation of the following month of the Tattered Air Mobility Requirements Board under Lt. Gen. Hamilton House.

At the same time, McNamara wrote to Air Force Secretary Zuckert that if the Air Force did not concentrate on developing airfield capability, it was threatened with loss of its mission to the Army.

This resulted in formation of the Special Air Warfare Center last April. The Air Force did not concentrate on developing airfield capability, it was threatened with loss of its mission to the Army.

The Air Commando are operating with Helix 1-15, F-104, F-105, Douglas C-47s and C-46s in addition to the B-26 and T-28.

The results of the House Board were modified in the Portuguese last August. The Air Force created its own board to review them. Its recommendations were forwarded to the secretary of defense. A small section of the House Board is still operating in the Pentagon to plan the support recommended by the board and approved by McNamara. The Fiscal 1961 defense budget will include these projects.

Army Special Forces training is centered at Ft. Bragg, N. C., while Army aircraft development is centered at Ft. Rucker, Ala., under the auspices of the Army Aviation Board.

NASA Accelerates Biotechnology Effort

By Alfred P. Abramo

Washington—National Aeronautics and Space Administration is making its first concerted effort to assess areas of potential needs in biotechnology with a full-scale ad hoc research program that includes development of a life support station to sustain space crews for a year or more.

Advanced life support program was launched by Dr. Eugene B. Kenerly, Administrator, and includes research groups, part of the National Aeronautics and Space Administration's Office of Advanced Research and Technology. Within next six months Dr. Kenerly's group will accelerate work in these areas:

- Life support systems with capabilities of 30 to 40 dry tons, dry to wet, monthly and a year or more.

- Psychophysiological monitoring system, including a compact biomedical computer that will integrate data, monitor measurements on spacecraft crew members over one single report.

- Closed life systems for use in space, outside of space vehicles.

- Biological food with low consumption of human wastes and chemical power.

Chief note, the pace of development of life support equipment has been determined by operational needs. Present capabilities in Mission spacecraft is a maximum of about 15 to 20 tons.

Contract negotiations are to begin

within a few days as a nation that will support life for 30 to 40 dry tons. This biotechnical station is to be demonstrated by June in a five-ton *Midas* test which will include a test of diet being planned for two-week, Columbia flight. Items in the diet include lettuce, cauliflower, dehydrated foods. The demonstration will be done in cooperation with the NASA-Manned Spacecraft Center, Houston, which will monitor the research.

Research step in developing life support equipment for long duration flights, space stations or lunar bases will be an open competition this spring as a series of studies of supporting life, not for three to five years. This contract will be monitored by the Langley Research Center, which has developed space station concepts.

Life Support

Dr. Kenerly and his office plans to send out requests for proposals to a research life support station about July. The Ames Research Center, Moffett Field, Calif., will be the NASA technical monitor for the work, which may include man, then one contractor. Dr. Kenerly and his office conducted a rather extensive review of both the existing life support technology and the probable needs for long life systems.

"We could see there was not much point in further study," he said. "There was a clear need for develop-

ment of hardware and an effort to get ahead of the potential demands."

Technicians and technologists will be led from one life support development project to another, he said, "so that by the middle of 1981 we should be well on our way to development of a man-rated system."

Since they were developed to provide life support for a relatively short time, the system in the Mission spacecraft and those being developed for Gemini and Apollo depend on storable oxygen and carbon.

The long-duration system which NASA now seeks to develop will use respiratory gases.

Advanced station also may use a two-gas system instead of the 100% oxygen system used in Gemini and Gemini 2. The Soviets have indicated they use a life support system with a closed and natural space flights that would duplicate the terrestrial environment—50% nitrogen and 50% oxygen at 14.7 psi.

There is some question that extended flights of 30 to 40 days could be made in oxygen toxicity, that is, poisoning judgment and ability to perform. Studies are now under way to determine whether more than 14 days on straight oxygen produces these undesirable effects.

Fuel Cell System

Contracts will be let shortly for development of fuel cell system using hydrogen as a source of electrical power. Field energy management probably will be provided by the Langley Research Center.

The development of the psychophysiological monitoring system and bio-instrumentation simulation at the NASA Flight Research Center, Edwards AFB, is also scheduled for this spring. The simulation will be scheduled for Edwards about Feb. 20, submission of proposals about Mar. 15 and selection of a contractor about a month later.

Contract will be for development of new, better sensors, displays that will give real-time information, possibly in three dimensions and console and recording equipment.

Dr. Kenerly said the bio-instrumentation facility at Edwards would be used to develop a biomedical computer which would provide monitors on earth with an integrated real time report on the condition of spacecraft residents.

Present information on such data as temperature, heart beat and blood pressure is reported. The biomedical computer would integrate this information into a single display indicating the overall condition of a station. An

interesting biomedical computer would advise the person responsible for maintenance of necessary medical resources. Dr. Kenerly said.

Biomechanical facilities would make possible more profound selection of astronauts and ground crews. Dr. Kenerly said, by integrating astronautics with the space station and other subjects, these developments and agencies to coordinate combined stresses and conditions of space flight. Ad- vanced bio-instrumentation systems also would aid in testing equipment for the design of flight equipment.

Manned Spacecraft Center is now developing for Dr. Kenerly's group a test unit to be used in the long-term life support system. The work in Houston is an extension of flying life development conducted by the Air Force.

Manned Spacecraft Center work is being done by Dr. Kenerly's office and in part an effort to provide a capability for manned flight outside a spacecraft. MSG will evaluate flight control, life support and propulsion systems. Studies already are being developed to assess of spacecraft autonomy and return to earth from disabled spacecraft.

In meeting the program of his office, Dr. Kenerly said, "we are concentrating with operational problems but in developing advanced systems on the basis of available future systems. Over the technology is developed, it is turned over to the line, in part over NASA's Office of Manned Space Flight."

Extended MA-10 Flight

Plans for a two or three-day night flight that would bridge the gap between the end of the Mission program and the beginning of the Gemini program, are under review by the National Aeronautics and Space Administration, McDonnell Aircraft Corp. and General Dynamics Aircrafts. Whether the mission actually occurs depends on technical, monetary and political factors.

NASA and its contractors are studying how the capability of the present Mercury vehicle can be extended. "We might go for two days," one NASA source said, "or, if we had, we could do it, we might go for three, four or even five days." Others believe, however, that two days represent the maximum extension of the Mercury spacecraft and Atlas booster combination.

Factors that will determine whether or not MA-10 ever becomes a reality include man or failure of the MA-10 and the date on which it flies, the size of the NASA appropriation for FY 1968, and in particular, the amount of money allotted for manned space flight and related evaluation of the configuration of a one-man, seven-day flight would make in Gemini and Apollo.

New Agency Proposed to Oversee Management of U.S. Departments

Washington—Creation of a permanent government agency to "Administer Government of the United States" to oversee the management and other government departments and agencies was recommended in a comprehensive report released last week by the White House.

The report was compiled by an Administration Commission established by presidential order in April, 1968, to make recommendations for improvement of administrative processes. The commission was headed by an 11-person board, chaired by the President, and included representatives from 13 government departments and agencies and 29 non-governmental organizations.

The board was headed by E. Brent Pritchard, senior policy of the U. S. Court of Appeals for the District of Columbia, and included James M. Ladd, a former National Aeronautics and Space Administration member. General commission membership included representatives from Defense Dept., National Aeronautics and Space Administration, Energy, Commerce, Federal Reserve, Agriculture, and CIA.

In effect, the commission recommended establishment of an separate unit to oversee the management of the government, to be headed by the President, and to be composed of representatives from all government departments and agencies.

The need for continuing study and action to improve government administration was emphasized. "The entire focus is to deal with can only be characterized as 'bureaucratic lag,' the report commented. "They do not lend themselves as a rule, to 'experiment' and 'try'."

"Not specific measures and reports but steady observations of experience and frequent evaluations of ideas are the means of eliminating bureaucracy," the report said. "The concept of a White House agency was discussed as 'unworkable.' The report explained.

"The scope of government is so great that any central body would be overwhelmed. The concept of a White House agency was discussed as 'unworkable.' The report explained. "The scope of government is so great that any central body would be overwhelmed. The concept of a White House agency was discussed as 'unworkable.' The report explained. "The scope of government is so great that any central body would be overwhelmed. The concept of a White House agency was discussed as 'unworkable.' The report explained.

The report recommended that the President's Office be given the responsibility for overseeing the management of the government, to be headed by the President, and to be composed of representatives from all government departments and agencies.

any single step to ensure, in virtually any effort, and to ensure administrative methods. No single formula, whether in nature or in shape or in an Executive order, could be enough at the present stage of activities of federal agencies in the actual administration that shape those activities in potential results.

The proposed U. S. Administration Commission would make recommendations to the President, the Congress, and to other departments and agencies. The commission would be authorized to develop a staff of specialists, and to make recommendations to the President, the Congress, and to other departments and agencies.

In organization, as outlined in the report would be:

- The Council. This would be headed by a chairman appointed by the President and confirmed by the Senate for a period of five years. Ten other members would be appointed by the President for five-year terms. The chairman's selection would be comparable to that of a Vice President of a Cabinet department.

- The Assembly. This would be composed of not more than 100 members, drawn proportionately from government. This would serve for technical and other resolutions recommended by the Council. The permanent members would be designated by their agency heads, the non-permanent members by the Council. Each Assembly member would be assigned a responsibility, and would not serve as a representative of any government or non-government organization.

Finds to Buy MG-21s

Florida defense agency has ordered reports that Florida is to buy 21 MG-21s, a new type of aircraft. The aircraft is a 317-hp engine, 100-hp engine, and a landing gear with a maximum weight of 10,000 lbs.

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Congress to Examine Offensive Flexibility

By George C. Wilson

Washington—Congressional concern over the cancellation of the Skybolt missile is fueling new interest in the longstanding question of whether the Kennedy Administration is losing the offensive flexibility it possessed by relying too heavily on missiles in opposition to manned air craft.

The issue over the next several months will pit leaders in Congress against Defense Secretary Robert S. McNamara in a series of House and Senate armed services committee hearings aimed primarily to be the last word on President Kennedy's current official policy. Although the Skybolt cancellation (see p. 51) will dominate the early hearings, Congress this year also will challenge Administration policy on military space, Air Force cooperation with the National Aeronautics and Space Administration, weapons to India, anti-ballistic missile development, abandonment of much of the Navy's fleet, anti-submarine warfare development and fleet expansion for the U.S. Polaris deterrent, nuclear-powered missiles, and evolution of the armed forces through executive action.

Several Republicans believe many of the Kennedy Administration's military decisions can be traced into national campaign issues, while some Democrats are becoming concerned with McNamara's attitude abroad. For example, Chairman A. Wiley Robertson (D-N.Y.) of the Senate Defense Appropriations Subcommittee said "The Secretary of Defense is a very brilliant man but he is also a war statistic man." Sen. Robert F. Kennedy (D-N.Y.) has been unsuccessfully urging McNamara to place more emphasis on manned bombers.

Legislative Uncertainty

Between the political maneuvering and personal dislike, there is a large amount of genuine uncertainty among informed lawmakers about President Kennedy's military policy. Several senators and representatives told AVIATION WEEK & SPACE TECHNOLOGY this summer intended when Skybolt was canceled.

Chairman George Mahan (D-Tex.) of the House Defense Appropriations Subcommittee said "The cancellation of the Skybolt project, along with its evolution of accommodation to come forward on an \$85-70 weapons system, gives me a lot of concern. We are not phoning ourselves out of the strategic bomber business too rapidly. . . I don't like to see us limit ourselves to ballistic missiles. We need to have a real hard look at this." Rep. Nelson said these

views are widely held in Congress, that the lawmakers who apparently the money want to know what the alternatives are to manned aircraft equipped with such as long-range missiles as the Douglas Skybolt.

Rep. Condit R. Ford, Jr. (Mich.), ranking Republican on the powerful House Defense Appropriations Subcommittee, expressed similar fears about the Kennedy Administration's military policy. He said McNamara emphasized the need for a mixed force and pointed out not to rely on any one weapon system. "But now," said Rep. Ford in reference to the phasing out of bombers and cancellation of Skybolt, "we're putting everything in one basket."

If Rep. Ford becomes convinced the Kennedy Administration is doing this, let us in an extreme position in terms of this decision into a Republican campaign race between now and 1968. Not only does he have the solid platform of the Defense Appropriations Subcommittee to stand on, but he was elected last week as chairman of the House Republican Conference, which gives him a bigger say in party affairs.

Skybolt Cancellation

Chairman Richard B. Russell (D-Ga.) of the Senate Armed Services Committee and Carl Vinson (D-Ga.), his House counterpart, will explore in detail the implications of the Skybolt cancellation during hearings expected to begin later this month. Both men have advocated more emphasis on manned bombers and are expected to oppose their plan this year. Sen. Claiborne D. Gadd, member of the Senate Senate Committee, echoed Rep. Ford's doubts about concentrating U.S. resources on missiles.

Sen. Everett Scherwell (Mass.), ranking Republican on both the Senate Armed Services Committee and Defense Appropriations Subcommittee, said the cancellation of Skybolt raises the question of whether some emphasis should be placed on the North American F-105. He said "The House has decided that question in favor of manned bombers."

What bothers many members of Congress is that Skybolt was canceled by the same Administration right after they were assured it was a solid weapon. "I'm a lawyer," said Sen. Scherwell, "in explaining this parliament. So when the technical people tell me they may say, I feel our function is to try on the side of national security. We appreciate the amount of money needed and then let the Pentagon fight it out." But in the Skybolt case, there was no apparent disagreement on technical

grounds when the funding request came to Congress—but it was canceled partly on technical grounds.

Last Jan. 19, McNamara told the Senate Armed Services Committee "I personally met with the Douglas executives in charge of the Skybolt development on two occasions in the past several months. I have discussed it on a number of occasions with the Air Force, particularly with Gen. Schriever. I think it is our joint opinion that the development can be completed within several months. He said all the money needed for Skybolt was being provided, and that the only financial problem was that the cost of \$214 million for research and development had proved low.

Manned Bombers

At another point in the same hearings, McNamara said, "We must be prepared to have manned bombers as our basic long-range force in the 1970s, and to that end we must carry on development work that will permit us to bring in new manned bombers, if that seems desirable in the latter part of this decade and that development work is being continued."

The Defense Secretary said "Obviously, the size and kind of force we will need in the future will be reflected in large part, by the size and kind of long-range nuclear forces the Soviets could bring against us and our allies and by the effectiveness of their defense system. If we assume, as in fact we have, that the Soviet Union will eventually build a large ICBM force, then we must concentrate our efforts on the kind of strategic defense forces which will be able to ride out an all-out attack by nuclear armed Soviet ICBMs as well as sufficient strength to make back demands."

"In order to impose their choice of penetrating to their targets, the manned bombers will need the help of nuclear air support of cruise or delivery—Hound Dog and Skybolt—background missiles and Minuteman ICBMs," McNamara said in the same presentation last year.

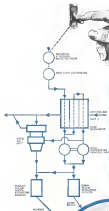
"These targets could also be attacked directly by Atlas and Titan missiles because of their heavier warheads, but they are less accurate than bombs dropped by manned aircraft. The Polaris has the greatest tactical potential of any of our long-range delivery systems in a nuclear war environment. Thus, a properly balanced combination of all of these weapons returns is required and provided for in our strategic forces," he said.

These and other statements by Administration leaders will be used to the




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South American Route Pooling Studied

Washington—Drive to consolidate several major international routes of Latin American carriers into a single service will be launched next month, but prospects are bright that no far-flung type of agreement will emerge.

Five carriers—American Airlines, Aeromexico de Mexico, Avianca of Colombia, Varig of Brazil and Viasa of Venezuela—are to meet next month in Bogotá to discuss a proposed pooling system. Under the plan, these five carriers would operate jointly five major route segments between the U. S. and principal markets in Latin America. The fleet behind the drive is Robert M. Berry, president of Varig.

Although little hope is held for a full agreement on a wide-scale pooling plan, U. S. carriers leaving South America are viewing the forthcoming meeting with caution. Any form of pooling among Latin American carriers, no matter how firm its structure might be, would obviously reduce route variations and rapid passenger traffic controls already imposed on U. S. airlines (AVT Sept. 13, p. 18).

So far, the U. S. government has made no move to curtail the concept's disadvantage (a which U. S. carriers have been pined as a result of these operating conditions). Principal Caribbean island carriers in the Latin American area lie in the pending South American Route Interchange designed to induce competition between U. S. carriers in this region.

One pooling plan, generated by Colombia late last year, called for a mix-

ture of the participating airlines into a single carrier to serve major international routes. The plan, however, had a cool reception and has been rejected as too drastic a move. As one South American airline official put it: Latin America is not "politically" ready for a continental carrier.

The Berry pooling plan only for an agreement in participating airlines of major routes between the U. S. and South America, a pooling of revenues and a division of profits according to an established formula.

The Berry plan is designed to stave off competition in South America from carriers and at the same time, enable airline carriers to retain their identity, an important factor in an consideration of Latin American route structure. National prestige has been the chief reason why governments have willingly subsidized heavy losses incurred by a large number of carriers operating on routes to the continent.

There is little evidence that these governments have become disenchanted with the drain on their treasuries. As a result, widespread governmental support of the pooling plan is not likely. In addition, the airlines act not only against among themselves what form of pooling would be acceptable as sheltering, is the answer to the Latin American airline problem. Viasa, for example, has indicated that it is opposed to any form of merger; there it will show a profit this year and is no doubt on government funds.

Avianca, until recently a somewhat sup-

porter of the single airline concept, is now expected to back a loose cooperative effort to cut costs and eliminate overlapping of routes. Carrier pressure will join in a pooling of route usage facilities and sales and marketing functions, but will not be willing to share its equipment in a pool.

The Colombian carrier still feels there may be certain areas where a single Latin American carrier would be justified, particularly in routes where European and U. S. competition is strong. But the airline is now convinced that few carriers and their governments will surrender their independence to join such a union.

Aeromexico claims it is not losing money, but that it could eliminate unnecessary costs under a pooling plan.

Aeromexico de Mexico has been losing heavily, but there are other factors that limit the carrier's losses from the pooling plan. The airline approved a proposed guarantee of Mexican airlines several years ago, guaranteeing because the merger would open its one good route—Mexico City-Los Angeles—to more competition. It is not considered likely that the airline will give its South American competition an opportunity to share traffic in this high-density route.

Aeromexico Argentina has not committed itself to the pooling plan. It is definitely opposed to any union that suggests merger and is expected to set itself toward any pooling plan that would affect its independence. The carrier also has been losing money.



Work on First Super VC.10 Fuselage Advancing

Work on the first of 10 Super VC.10 (preorder on order for British Overseas Airways Corp.) is advancing at the Vickers Wertheby facility of British Aircraft Corp. Fuselage section is shown as an assembly before and has a 75-in. fuselage extension incorporating the first passenger windows, all of the forward galley section. Additional 83-in. extension is located aft of the wing. Overall length of the Super VC.10 is 271 ft. 6 in. Standard VC.10 is 195 ft. 6 in. Maximum passenger accommodations in the Super VC.10 is 180 compared with 140 in the standard version. First flight of the aircraft is scheduled for July 1966.



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LUFTHANSA and BERGARD WORLD AIRLINE operate a twice-a-day round trip freight service between Frankfurt and New York using Scheuch's swing-bell 40,000-lb capacity Carrier CM cargo aircraft under a recently renewed agreement. Lufthansa says the service enables the carrier to meet increased demand for cargo service.

Lufthansa Finances Critical Despite Gains

By Edith Waldorf

Cologne—Lufthansa West German Airlines, despite record first-half gains last year in passenger and cargo revenues, is facing its most critical financial period since its postwar renaissance.

With an anticipated 1962 loss added to its record deficit in fiscal 1961 of approximately \$25.5 million—including depreciation and maintenance charges amounting to about \$7.75 million—the airline has a rough financial road ahead. It will require several years at least before Lufthansa can reach the break-even point, even if the carrier succeeds in maintaining the present favorable trend in its financial health.

Outlook for 1962 results appeared to be optimistic brighter than 1961, however, and Lufthansa expected to close 1962 with an acceptable lower deficit, largely because of an increase in capacity of only 25.6%, lowest in the company's history.

Up to 25% of Lufthansa's capacity is offered on its North Atlantic routes, and it registered an increased 28% traffic increase on those routes in 1962. Preliminary overall operational figures for the West German airline also

show modest advances. Their totals: •200.7 million new miles sold, an increase of 23% over 1961.

•1.9 million passengers carried, an increase of 21%.

•21.5 million tons of freight carried, a 26% increase.

•14 million tons of mail carried, a 30% gain.

With mounting financial losses, Lufthansa plans in 1963 to ease the pace of its network expansion, which has been pushed on an accelerated basis since the airline's re-emergence in 1955. Although additional services are planned in several other airports in the carrier's route framework, only one new route is expected for the year—Düsseldorf to Vienna.

North Atlantic routes, however, now may be poised for a major problem, and the company's heavy 7400 line was also generally to the mid gap between capacity and seats sold a factor which will most North Atlantic carriers have had to contend.

Moreover, the West German carrier's capacity during 1961 increased by 55%, while seats sold increased only 41%. Consequently, the 54% over-all load factor during the same period fell four

points below that of the previous year, although Lufthansa's share of world air traffic rose by 8.5% to 3.5%.

Longer range plans of traffic rights now being negotiated are granted, in this connection at Boeing 720s on new services during the 1963-64 period to Venezuela, Colombia, Ecuador and Peru.

As an interim measure until the Boeing 720s are order because available, Lufthansa also plans to introduce Boeing 730s as most of its long European routes early this year as replacements for its Vickers Viscounts 814, Convair 440 and Lockheed L-1649C Super Constellation 30s.

However, Lufthansa will soon deliver its first six Boeing 720s in early 1964 before effecting its planned gradual complete change-over to jet service on its international European network.

New Düsseldorf-Vienna 730B service will be utilized only during the peak summer season, with a stop at Frankfurt. Proposed frequencies has not been determined.

Lufthansa last May introduced a third weekly Boeing 720B round trip service to the Far East. It initially terminated



Sure, you can oil it, grease it, wash it, polish it if you want to...but only for parades

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sticks. Bell-swivel optical disconnects are used on fuel lines to inspect and maintain, eliminating system damage prior to removal.

Accessibility has also been given major emphasis. Integral steps, walkways, and work platforms have eliminated external stands and ladders; many components are accessible from ground level. Critical dynamic system components are designed for 1,000 hour tours between overhauls.

Extremely speaking the only time you have to grease, wash, or polish the Sea Knight is for parades.

Creative engineering, careful thinking, weapons system package management and the vast resources of The Boeing Company have made the Sea Knight possible.



at Hong Kong, but was extended to Tokyo on Oct. 1.

Radiating the need to improve access and fully exploit the traffic potential on some of its major national routes, Lufthansa is planning to introduce a new capacity schedule service between Frankfurt and Hamburg at a three-times-daily frequency beginning Apr. 1 for a seven-month trial period.

If it proves as profitable as hoped, the service probably will be extended to include other heavily traveled routes, such as Cologne or Düsseldorf/Munich and Hamburg/Munich.

Boosting its operation on U. S. highways, Lufthansa will add no new aircraft to the 56-passenger Lockheed L-394HC Super Constellation on these flights, nor can seat reservations be made in advance. Tickets will be sold ahead of the season.

It is expected that the reductions in overhead will enable the carrier to reduce the ticket price by about 25% to a point comparable to a first-class rail fare within West Germany.

Post agreement signed by Lufthansa with Deutsche Airlines on Oct. 25 has been working satisfactorily since it began on Nov. 1, according to Lufthansa officials covering their third fourth-quarter traffic between West Germany and Canada, it was later be extended to cover the joint operation of other branches of the two carrier's service, the German airline says.

Lufthansa's current jet fleet is composed of five Boeing 707-400 and seven Boeing 720-100s. Two Boeing 707-1200s will be added, one next spring and the other in 1964.

First six Boeing 720s of the total order of 12 are scheduled for delivery in the summer of 1964; the remainder in the spring of 1965.

The 149th aircraft in range of the Boeing 707-1200 is the 707-430 will arrive Lufthansa in 1965 to operate its Frankfurt-San Francisco service stop. At present, those flights include a stop in New York.

In Lufthansa's opinion, the initial high cost of future jetliners compared to transports will induce a number of airlines to pool their fleets and operate them over certain routes on a cost-and-profit-sharing basis. "Such a move was at a planned under the provisions of the Future Air Union line company partnership," Lufthansa officials stated.

"Not yet having had time to absorb the cost of air jet equipment, purchased or still on order, we feel we will be able to afford their own independent operations fairly by the early 1970s."

In another effort to cut losses, Lufthansa suspended its domestic Paris route this year, the last time he more than



FINAL DISBURSEMENT is conducted on a Boeing 707-1200 jet engine on Frankfurt flight last year in departure.

1960. Carrier officials stretched the need for the increase in the high operating costs of Lufthansa's Viscount 514 and Caravelle 440 fleet over its short domestic routes coupled with a 1970 rate for Apr. 1 in airport landing charges in West Germany.

During 1961 the carrier's tailwind and landing charges at Frankfurt Airport alone amounted to about \$345,000. Commanding its in-flight relations with Scandinavian Airlines System and the frequency with which Lufthansa leads in Scandinavia and SAS in West Germany, Lufthansa was still SAS—only about 85% of the traffic over the route structure—represents a dilemma in its service.

However, Lufthansa says it is confident that a more balanced traffic agreement will eventually be reached with the Scandinavian carrier, even though Lufthansa may have to wait until it can bring more pressure to bear on SAS than it present through the Air Union consortium.

In terms of passenger service, Lufthansa says that during 1962 it surpassed SAS over the North Atlantic route. At the moment it talks about only minor traffic increases, according to Pan American World Airways, British Overseas Airways Corp., Trans World Airlines, Air France and KLM, Royal Dutch Airlines.

Reverts to date of the cargo-carrying agreement concluded with Scandinavian World Airlines in the North Atlantic route which became operative last a one-year period last Jan. 7. Now both bodies from growth expected according to Lufthansa's freight manager, Heinrich F. Klump.

The 20,000-lb cargo capacity allocated Lufthansa in Scandinavian's Constellation CL aircraft on the main daily transatlantic cargo flight in the U. S., together with the freight capacity available on its own

Boeing 707 transports, is providing a steady source of revenue, Klump told. The agreement between the two carriers was recently extended to June, 1963, and Lufthansa has a further source said end of 1963.

Lufthansa officials, however, declined to comment as to whether the carrier reportedly might be interested in purchasing its own CL-44 type freighter usually for the transatlantic route.

Upward revaluation of the West German currency, comparing East West political tension resulting in decreased tourist traffic during the peak summer months on the North Atlantic network, and pressure on jet equipment and spare parts in recent years that were cited as factors contributing toward the carrier's loss in revenue in 1961 (AW Feb. 26, p. 46).

FAA Predicts Surge In Airline Business

Washington—Federal Aviation Agency last week predicted that U.S. domestic and international airlines will handle 87 billion en route passenger miles in 1963, compared with the 81.5 billion carried in 1962.

In a bygone forecast, FAA's office of policy development said that international revenue passenger miles will increase at a greater rate than domestic traffic. Contributing factors in the expected growth are an expanding economy and population, reduction of short-range jet aircraft and substitution of the newer series.

The forecast predicted that air carrier fleets will be reduced in size as a result of increased working capacity. Total of 1,750 aircraft is anticipated for the U.S. before Dec. 31, 1963, compared with the 2,000 now in operation.



Northrop had many problems building its latest communications system.

Hit and run This is how Viet Cong guerrillas operate. And these tactics were frequently successful because of South Vietnam's lack of adequate communications.

To overcome the problem, Northrop was called upon to build a complete military communications network across this treacherous country.

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One was Viet Cong guerrillas.

mountain ranges. Where roads were non-existent or impassable, they built new ones. Lacking heavy construction equipment, they improvised with the labor of willing but untrained Vietnamese men and women.

Electronics and mechanical equipment was flown in from the United States and hauled to construction sites by truck convoys, rice boats, helicopters, and primitive shoulder poles. Every movement was made under armed guard, for

there was always the threat and the actuality of ambushes.

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AIRLINE OBSERVER

- Indications are strong that George E. Kerk, now president of United Air Lines, will be named president of what Kerk has moved into one of the strongest positions within the airline's management ever held by an airline other than Pan Am. All but a few department heads now report directly to Kerk, whose title includes general manager as well as executive vice president.
- South African Airways is exploring the feasibility of a west Africa route to be used in the event that several African treaties close their airports to SAA as a protest against South African racist policies. Such sanctions have been threatened by Southern Rhodesia, Kenya and Republic of the Congo for airports at Salisbury, Nairobi and Kinshasa. SAA has made a passing flight to test an all-Portuguese route to Europe and Britain via London, Angola, Sal Island, the Cape Verde Islands, Lisbon and Rome. Airport law would seem direct SAA flights to Rome and Athens, and otherwise Portuguese territory routing would be 3 hr. longer than the present shortest route between Johannesburg and London.
- Abandonment of the on-show penalty plan beginning Feb. 1 is another sign of basic disagreement within the domestic airline industry on operating costs, and how to share further difficulties in settling on a book formula and reaching accord on a form of cumulative expense through reimbursement of freight benefits to the passenger. The plan never did have the complete support of all carriers, and failure of the local service carriers to adopt it, helped bring these differences into the open. Overlooking passengers under which airlines pay passengers a fee when overbooked have been confirmed but a test is essential, will be retained.
- United Air Lines is now stocking Boeing 727 turboprop transport parts for preliminary testing, tuning and possible work in preparation for accepting delivery of the aircraft in late 1983.
- Electric train service has been inaugurated between downtown Moscow and the Russian capital's new Domodedovo Airport, located 25 mi. south of the city. When the Domodedovo installation becomes fully operational next spring or summer, passengers will be able to walk directly from the train into the airport terminal waiting area. At present, Domodedovo is accessible as an alternate airport if Vnukovo and Sheremetyevo are shut down by weather.
- National Aeronautics and Space Administration has awarded North American Aviation a contract to build two wind tunnel models for supersonic transport studies. One model will be a swept-wing conceptual airline transport and the other an air intake inlet model.
- Civil Aeronautics Board has awarded the design and aircraft flight permit record Dec. 5 to Transponte Aereo Uruguayo of Uruguay on grounds that recent information reveals that the principal stockholder of the company is an American citizen. In granting the application, the carrier was registered as being wholly owned by citizens of Uruguay. Permit was cancelled because the carrier failed to respond to a telegram asking for an explanation of the discrepancy.
- CAB Executive Herbert K. Bryan has recommended that operating rights of TWA at Williamport and Scranton/Wilkes-Barre be transferred to Allegheny Airlines and those at Albany and Buffalo to Mohawk.
- Six design flight tests next month could test work on their bed to prevent the CAB from requiring foreign airlines to file schedule and capacity data with the U.S. A U.S. district court issued a motion by the carrier to have the CAB dropped from serving the President to grant the broad judicial authority over foreign carrier schedules to and from the U.S.
- The Australian World Airways and Trans World Airlines have filed a joint petition to defer proceedings in the CAB Transatlantic Route Review Case for six months. Because the motion created a conflict of procedural rules, Examiner James S. Keith suspended all proceedings until further notice.

SHORTLINES

- Air Transport Assn. last week filed a new department of information services by consolidating public relations, research and library services. New department will be headed by Craig Lewis in director of public relations. Lewis, former deputy director of public affairs of the Federal Aviation Agency, replaces Thomas F. McGinnis, who resigned. In Montreal, S. Ralph Cohen accepted as public relations officer of the Air Canada. Air Transport Assn. to pay \$45 in interest to the president in New York.
- American Airlines has received Federal Aviation Agency authority to overhaul the mid section of the Airbus 321-D13 turboprop engine, which powers the Lockheed Electra even 3,000 hr., an increase of 1,600 hr.
- Bonanza Air Lines reports that half fare of its youth under 12 years of age more than doubled in November in the same month last year. A 52 identification card, good for one year is required to prove age and identity to qualify for the low fare.
- Braniff Airways will install business class distance measuring equipment, the DME-500, on all its aircraft.
- FAA certification has been granted the Boeing 98A turboprop transport, five of which are scheduled for delivery to American Airlines in March (AW Dec. 14, p. 31). The aircraft is an improved version of the 980 series, 45 of which American is now operating. Carriers will make its 98A through its Tulsa maintenance base for the 98A modification of wing and engine modification, improving speed and takeoff performance.
- Hawaii University's Paul Changchien last week urged that domestic trunk carriers and local service airlines get together and draw up a tentative plan which will resolve the economic relationship between these two industry branches and prevent competitive chaos.
- President Kennedy has designated Alan S. Boyd to continue as chairman of the Civil Aeronautics Board and Robert T. Murphy as vice chairman for another year.
- Radio Technical Committee for Aeronautics has established a special committee to define several air traffic control problems and develop an improvement program. New RTCA group is designated the "SC-104 Air Traffic System Committee."

DEPARTURES & ARRIVALS POSITION REPORTS RESERVATIONS WEATHER REPORTS

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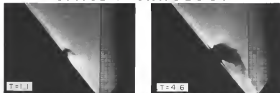
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ALUMINUM SPHERE. 1 in. model of meteoroid strikes head at an oblique angle (15 deg.) and throws out spray of debris shown in this photo sequence with time marked in microseconds after impact. Time scale with a scale on right of each photo. Impacting particle struck at 8,100

NASA Studies Hazards of Lunar Impact

By Barry Miller

Moffett Field, Calif.—Hundreds of lunar explorations caused by surface particles scattered from the moon when it is struck by high-velocity meteoroids will be assessed next spring by two projects experiments scheduled for the first Surveyor or soft-landed lunar spacecraft.

These particles—the debris thrown from craters or holes created by impact of meteoroids or micrometeoroids—may contribute to astronaut as the lunar surface a lethal danger approaching in magnitude that posed by planets or incoming meteoroids, according to results of independently repeat experiments recently conducted here at the Ames Research Center of National Aeronautics and Space Administration. The critical surface particles are called meteoroids, or secondary, ejecta.

Data collected at Ames indicates that the number of lethal ejecta which could penetrate an astronaut's protective suit approach the number of primary lethal particles by a factor of 10, thereby nearly doubling the danger to man

thought to live from the meteoroids.

As far as the spacecraft hull is concerned, its chances of being penetrated by secondary ejecta are a hundredfold or perhaps a thousandfold of those of being struck a killing blow by a meteoroid, according to this Gault research on impact when it is conducting simulated lunar impact studies at Ames. Lunar ejecta could be an serious or repair hazard, particularly for exposed scientific equipment or antenna parts such as antenna lenses, mirrors or solar cells.

Unlike the earth, the moon has no appreciable magnetic atmosphere, magnetic field, burn or disintegrates meteoroids. This means that in particular, vulnerable, to micrometeoroids, high-velocity impact studies. Large comets and asteroids in space throw particles but the moon with tremendous energy. Hitting in brief intervals of time smaller but still enormous quantities of energy and causing serious in the lunar surface.

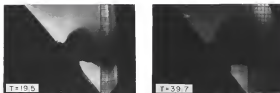
Clearly, man must face the frequency of meteoroid impact at the lunar surface is one of the things NASA hopes to

learn with projected Surveyor experiments.

Scatter experiments detector experiments are being conducted in importance only to the surveillance reference cameras on the first Surveyor or perhaps (JAN 6, p. 70), which is an indication of how serious the space agency views the potential problem.

Both Ames and the Goddard Space Flight Center have proposed ejecta detector experiments to NASA, which was expected to select the experiments it wants for Surveyor's first flight in the first of the year. Though differing in their approaches, these experiments are intended to count by scattered detector the number of primary and secondary impacts above a certain threshold momentum. Second generation experiments might measure velocity and mass distribution of the ejecta and momentum alone.

These simulation experiments on ballistics ranges here, Gault and his colleagues have simulated much of the complexity about the ejecta problem into quantitative data. Result, a strong ap-



camera/hous. Camera housing hit by 1.14 millimeter meteoroid. Ames Research Center data indicate meteoroid impact on the shown facility up to 30,000 miles from point of lunar impact.

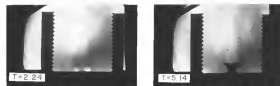
Particles

each rock regarded as a good equivalent of least surface material, is used as a target. By firing simulated meteoroid projectiles made of aluminum into it at speeds of about 7,000 miles/sec, Ames scientists have deduced that:

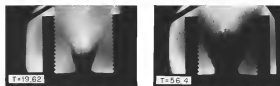
- Between 100 and 8,000 particles with a mass equal to or greater than the projectile mass are thrown from each crater on impact. Striking head at these velocities, aluminum projectiles create high stress waves generating primary ejecta in series of magnitude from strength of head that is, less of rail than gun contacted to 20,000-40,000 psi. About half of the kinetic energy of the impacting projectile is converted to kinetic energy as ejected fragments. The remaining energy is transferred by breaking and crushing rock, heating, etc.
- Ratio of ejecta of a given mass is greater to the primary particles of a given mass or larger a between 1,000 and 100,000 when the complete spectrum of particle masses striking the lunar surface is integrated. This ratio was calculated from computer data. Neither the primary nor the secondary



IMPACT CRATERING. Effect on metal targets is dramatically shown in this photograph of Comstock aluminum target which had been struck by 0.2 in. diameter sphere traveling at 14,000 fpm. Particle ejected from crater on impact could pose hazard to astronauts on lunar surface, Ames Research Center independently impact studies indicate.



LUNAR MICROMETEOROID IMPACT. problem being investigated in laboratory. Lethal size facility at Ames can be simulated from the sequence of photographs taken in test to simulate meteoroid impacting on lunar surface. Aluminum projectile (0.2 in. diameter) strikes head



(right), normally at 5,400 miles/sec. and particle ejected from crater appears as spray in these collides from per se, photos. Two bright spots, visible at head surface in first frame are caused by micrometeoroid gas from high-speed impact. Ejected side is 1 cm. between cratered points.



Orbit in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three dimensions. One of its experimental packages uses two piezoelectric transducers to the sun's rays. Other experiments must have two to the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar panels in continuous orientation with the sun; a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional, high-speed servo-motor without the usual problems of gear lubrication. It does its work by wobble or twist motion at a rate

of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include handling OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ALFA, and command systems management for the Air Force's Allen, Titan and Minuteman programs. These systems create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Astronaut and Microsensors, Avionic Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Program Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Foster, One Space Park, Dept. A-1-1, Redlands Branch, California or P.O. Box 4271, Patrick AFB, Florida. STL is an equal opportunity employer.



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load is known, but recent evidence suggests that the more conservative estimate of the frequency of micrometeoroid impact, based on criteria's made over 25 years ago, is correct. If a minimum astronomical population were assumed to exist at the moon, based on Harvard Astronomer Fred Whipple's estimates, such an intense concentration of objects would be discernible from the earth in a laser cloud or atmosphere, according to Gault. Since such a cloud does not exist, Gault said, assuming a maximum frequency of primary particles is unrealistic.

Conclusive evidence of the people now track actual laser reflector measurements.

- **Impacts tend to travel slowly compared with the velocities of the impacting particles** although laser reflector data is greater. Asteroidal particles that typically travel at 15,000 meters/sec. would scatter spectra 1,000-10,000 times the mass of the striking particle. Of these, 99.9% would travel at less than 100 meters/sec., or 1/10 the speed of the original particle, and 90% at less than 300 meters/sec., or 1/35 speed of the original.

- **Impacts will travel a substantial, long distance on the moon.** Ninety per cent will not exceed 10,000 meters altitude and all will be confined to a 30,000 meter radius distance.

Assuming the moon is covered with at least a thin layer of dust caused by cosmic impact, Apollo scientists have indicated such conditions exist and as a result. They found that if the particle is large compared with the grain size of the sand, there is no difference in the coefficient underlying the results cited for lunar targets. Laboratory tests show two or three times as much

mass thrown back sand as from earth. The speed of the asteroid sand would be greater than the speed of sand as a desert sand storm, although it would not have the spiral density of the desert storm. Thus if it is misleading, Gault said, to imagine the spectra photo-sensitized to be as intense as a typical sand storm of the southwestern United States.

Test properties on aluminum because at the high speeds involved the nature of the projectile material is irrelevant to being in the dense, high-velocity that of viscous material, stone. Aluminum was selected because it is structurally stronger than glass and easier to handle in the laboratory. Average particle size varies in diameter from 0.1 to 0.25.

Projectile speeds in the range do not match those of meteoroids, but all evidence suggests that the mass of objects is roughly equivalent. Extrapolation from a possible of 7,000 meters/sec. range speeds to the 15,000-70,000 meters/sec. speeds of meteoric particles.

Micrometeor material may aggregate from the asteroid belt, and, possibly, through a gas or dust, and from the remnants of comets. The latter particles are more often less than a grain in weight. Asteroidal material moves more slowly, and would probably strike the moon less frequently than meteoric material. Cometary material is the more populous and is statistically the greater hazard.

Recent hypervelocity impact studies aimed at understanding phenomena and mechanisms of impact, particularly at micrometeor particles with reference to the lunar surface and its environment. Further, the studies can also aid in interpreting how the moon's



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CINCINNATI



HYPERVELOCITY ballistics gun and range facility on which simulated lunar impact experiments are conducted at Ames Research Center are shown above.

Television eye under the sea

Bell System experiments with ingenious TV vehicle to view ocean floor and inspect vital undersea cables — another way the Bell System seeks to assure high reliability of military and civilian communications.

Undersea cables provide important paths for military and civilian communications.

But, until recently, it was impossible to view these cables on the ocean floor and examine their condition.

Now this may be changed.

In a recent experiment, Bell System scientists viewed submerged cable via an unusual underwater TV vehicle.

From a surface ship, the vehicle was driven to the ocean floor and located cable via the TV camera.

By remote control, the vehicle was maneuvered along the cable's path.

This was the first systematic study ever made of undersea cables.

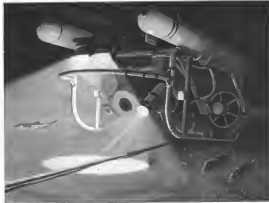
And by it, the Bell System learned many things that will result in improved designs to meet ocean bottom conditions and permit further advances in cable laying techniques.

The underwater television vehicle is another illustration of how Bell System ingenuity is constantly at work to assure round-the-clock reliability of military and civilian communications.



Bell Telephone System

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This underwater television vehicle beams light and TV camera to inspect cables as deep as 200 fathoms. The vehicle is self-propelled, guided by remote control from a surface ship. Originally designed by Westinghouse for other uses, the vehicle was modified and adapted by Bell System engineers for cable observation.

under was formed. From this work, now will be learned about least surface bottom, possibly influencing the design of hull structure and moving hull vehicles.

In typical experiments, projectors are fixed and spot targets and visual output from the camera is collected. Patterns are taken during flight with high-speed framing camera operating at 5,000-1,000-800 frames per second to view critical underwater lines the camera and the trajectory the material follows in flight after evaluation. By measuring the center and the size of the target before and after observation, beam experimenters can calculate on how low natural material might be distributed.

Examination of the size frequency distribution of spots and conclusions with the direction of the trajectory and material velocity indicates the distance material of a given weight might travel.

Measurement of the flight of the object in relation to the controlled flow of material during the tests gives an estimate of the total number of particles in burst light at any time. Tests have been conducted in a 6-ft gun and range environment. A safe splash pattern is chosen by power change to compensate for wind, temperature and pressure. The level gun sensor or is released through a quick opening valve to drive the projectile toward the target.

Tests have been conducted in a 6-ft gun and range environment. A safe splash pattern is chosen by power change to compensate for wind, temperature and pressure. The level gun sensor or is released through a quick opening valve to drive the projectile toward the target.

profile toward the gun barrel in a robot for shooting. The projectile thus enters a portion of the range in which the pressure is that of unobstructed lower conditions. Speed shadowgraph pictures are taken at four stations along the trajectory to provide a more accurate picture from which projectile velocity is determined. Impact and velocity are photographed in the end of the range.

Other targets include balloons from an Acoustic oceanic meter, satellite and distance from earth, a set of points of small water-filled vessels, aircraft, parabolic, and several and a shielded steel.

Other conclusions of the Army work: • Spots from centers toward by impact at different angles will be somewhat toward the center of the crater, instead of in the direction of the trajectory. • Launch surface probably is covered with small dark but with visible ranging in poor size measured in no more than 100 angular blocks. This is supported by impact experiment on burst targets with these results following an active size distribution.

Army's latest impact work is done in cooperation with the U. S. Geological Survey and present studies are in only growth of their contacts three years ago at the suggestion of Eugene M. Strohman of the Survey, who is now with NASA.

NASA Awards \$10,800 To Mercury Inventors

Washington—Five inventors for the Mercury Mission receive the \$10,800 from the National Aeronautics and Space Administration.

Seven-year team involved in the spacecraft design shared \$4,200. They are: Myron A. Faget, Asst. Dir. of Man, Jr., R. G. Chilton, James R. Hunsaker, R. C. Johnson, W. S. Blanchard and A. B. Kibler. Faget and Myron each also owns of \$750 for deriving the escape tower release.

Money also received an additional \$10,800 from the space agency for developing the parachute and equipment platform system for Mariner.

Faget, William M. Blodt, Jr., and Jack Eberly shared \$2,100 for engineering the main restraint system. Eberly, M. Blodt and Frederick G. Wood each also received \$1,000 for engineering an altitude rate meter.

The recipients are all officials of the space agency's Mercury Spacecraft Center.

In earlier award, George P. Wood, Asst. Dir. of Man, and Dr. Adolph Bauman of Langley Research Center shared \$1,100 for creating a plasma streamer.

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PROBLEMATIC RECREATIONS 153

11

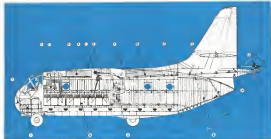
How many more digit numbers are divisible by 11, no digit equal to zero and no two digits alike? —Continued

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ANSWER TO LAST WEEK'S PROBLEM: The distance from Krypton to Rigel must be at least 25 miles. The town could then be located at distances 0, 1, 4, 10, 11, 23 and 25 miles from Krypton. There are 21 distances between towns and there are all distinct. Any shorter distance would mean at least one duplication.

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NC-142A INBOARD PROFILE DRAWING shows: (1) engine compartment; (2) passenger bar with entrance; (3) cabin interior; (4) auxiliary power unit panel; (5) forward fuel cell; (6) forward access ramp; (7) maintenance hatch; (8) wing entrance; (9) aft maintenance ramp; (10) aft fuel cell; (11) tail rotor shroud; (12) vertical tail fold line; (13) tail rotor; (14) tail rotor fold line; (15) aft access door; (16) cargo ramp entrance; (17) control surface integral hinges. (18) ground crew bay tail ramp.

XC-142A Detail Design Effort Hits Peak

By David A. Anderson

Detail engineering design work on the NC-142A V-STOL transport program is now in its final stages and is expected to be completed next week.

First aircraft being developed is a four of the V-STOL transport program, which is scheduled for delivery at the end of the year (AV Sept. 3, p. 34). Last of program check points are calls for the NC-142A to be at its first conventional flight in March 1964, and its first VTOL flight in May of that year.

With the exception of some minor changes to research the other V-STOL program, the basic design of the NC-142A is the same as that which was the baseline VTOL transport competition for the team.

XC-142A Concept

Concept of the NC-142A is built around a left propeller driven wing a lifting wing and the deflated elastomer from the 15.5 ft. diameter blimp. The blimp is inflated by a General Electric T94-GE1 turboprop engine rated at 2,500 hp. Design payload for VTOL mission is 5,000 lb. of

payload in 30 conventional transport. The transport is designed to carry that payload over a nominal range of 200 statute miles and to be in for 10 min. at the end-point of that mission.

Great weight was put on the mission, but an order of 10,000 lb. for VTOL operation.

As project contractor and system manager, Hughes' role is to run the program and to design and build parts of the airplane not assigned to other team members. This includes fabrication of the forward and center fuselage sections and design of the wing and landing gear.

Ryan's design and fabrication work includes the wing fuselage section, the tail surfaces and the nacelle. The company also is responsible for fabrication of the wing panels and design of the engine installation.

Hillier is charged with responsibility for the design and construction of power transmission systems, the power, air-conditioning ducting and the tail rotor. The company also will build the flap and ailerons.

The division of labor was part of the agreement made among the three companies when they decided to propose a design for the original transport competition. Hughes is leader of the team,

and two-thirds of the cost of the project. They chose Hillier because of that company's experience with high-speed transmission, and rather than the Hillier X-15 VTOL lifting research aircraft. Ryan's experience with the aircraft and control of a wide variety of VTOL and VTOL aircraft made that company's natural choice for the team.

Ryan and Hillier split the rest of the remaining third of the project effort. When the group was awarded the contract, the workload was proportional to each company's share of the project. That is why Hillier is building the flap and ailerons in addition to its work on the transmission, the support structure of the wing, which gave the transmission job to them did not quite make enough of the effort to do the contract.

Optimum Design

Team members have long since given up the task of trying to construct an aircraft that the lift wing plus deflated elastomer design is best or optimum. Thus, it is more "optimum" VTOL configuration is now an investigation of the various.

Instead, the Hughes Ryan Hillier personnel concentrate on taking into the design the configuration. Their approach

was to have design analyses on four configurations.

- Type specification had to be met.
- Design should be an airplane with VTOL capability, not a VTOL vehicle that could also fly like an airplane.
- Handling qualities should be easy to fly, all with VTOL efforts were to be done smoothly in this area.
- Reliability and maintainability, low cost design.

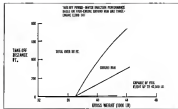
These criteria were applied to four basic types of VTOL design: lift wing, deflated elastomer, lift wing and deflated elastomer. The final choice of lift wing plus deflated elastomer was considered an optimum.

The classical problem of lift wing aircraft is penetration of wing stall into the operating range. Early test studies in VTOL program experienced this problem, with the most severe situation occurring during transition from forward flight to vertical landing.

In transition, the lift wing aircraft is decelerated by tilting the wing to the vertical. This increases the drag of the airplane, and it begins to lose speed and climb. Power is designed to produce further deceleration and an increased sink rate.

As the sink rate increases, the vertical velocity adds to the sink rate to the other velocity which decreases the resultant angle of attack on the wing, the fuselage velocity and the elastomer velocity.

Forward velocity decreases to the aircraft deceleration and the resultant velocity decreases as the power is at



TARGET PERFORMANCE CHART for NC-142A shows rate of possible operations in VTOL and STOL flight. Vertical line from any chosen pump weight gives ground run distance and total distance to clear a 50-ft obstacle.

deco, the result is that the vertical velocity movement becomes the dominant factor in determining the angle of attack over the wing. At the sink rate increases, the angle of attack over the wing increases and can put the stall angle.

Drag Increase

A very gradual descent will increase this problem, but the engine capability of the VTOL aircraft is not in such an operation. To make the transition smooth, an increase in time and distance the aircraft must be able to maintain an extended wing.

On the NC-142A, which combines the lift wing principle with the deflated elastomer approach to VTOL.

flight, this is accomplished through increasing the drag of the elastomer by deflating the flap. This requires the use of more engine power to maintain a given sink rate than is the case of the deflated, lift wing airplane. The increased power results in an increased elastomer velocity over the wing and compensates for the increased angle of attack due to sink rate and the loss of forward velocity.

Power management of power must take the relative angle of attack always below the stall angle. For any given wing lift angle, there is a angle relationship between power thrust and the forward velocity which must be maintained to avoid the stall.

The combination of the lift wing and



GENERAL ARRANGEMENT DRAWING of the NC-142A shows the general characteristics of the V-STOL transport. Wind tunnel tests have shown the need for lifting of rear of longitudinal plane and in vertical tail-fuselage area.



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defect-detection approaches is better than the filtering alone, for example. Vaughn concluded. At the other end of the scale, the combination shows a better bearing performance than a just selected algorithm type. Turning loose for the defect-detection VTOL aircraft are not acceptable, Vaughn engineers say.

Back to the XC-142A design is its HTP propulsion system, which is required to develop 18,000 ft of the engine gross weight in vertical thrust. The VTOL operations as a standard as load day. Each in the design, the team had to choose between propellers and rotors to satisfy the several conditions for forward, vertical and time-on-flight, plus the demands of stability and control. Then chose conventional propellers and a tail rotor to avoid a long development program for the rotor control system and the lightweight blades.

Hamilton Standard Division of United Aircraft Corp., which developed the propellers, used its lightweight rectangular gearbox as part of the design. There are overrunning clutches installed between each propeller and its driving engine.

Powerplants were originally designated as T64-GE-1, but a recent Air Force designation change for the engine is responsible for the recent model number of T64GE1. Future development of the T64 engine, used at 1,210 hp, is under way at General Electric's South Aircraft Engine Dept.

Engines are interconnected with high-speed cross-shafting, operating at 5,000 rpm, so that an engine failure does not produce catastrophic effects. Uncontrolled, an engine failure on one side could produce an uncontrollable rolling moment. The other end for the cross-shafting is to shift control power from one side to the other for control during hovering.

A takeoff from the engine cross-shafting drives an accessory gear box in the backlog, which has a shaft for the tail rotor drive shaft. There is a mechanical brake for the tail rotor.

At each bearing point in the cross-shafting, there is a constant, flexible-displacement, high-speed coupling using

XC-142A Performance

Design gross weight is 11,474 lb.
Max. VFO weight: no level road
and thrust/weight = 1.05, 41,330 lb.
Rate of climb at design takeoff wt.,
no level standard sea 6,000 ft/min
Maximum speed, no level 157 kt
Maximum speed, 10,000 ft 174 kt
End of action, design takeoff wt.,
no level cruise 150 kt
Heavy forward mission no level 18 kt
Maximum cruise speed 250 kt

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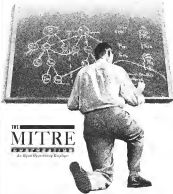
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networks and several customised variations utilizing TI's "Master Slice" technique of depositing special interconnection patterns on standard-diffused silicon slices. Engineers and management from Litton and TI worked closely together during another six weeks. At the end of this period, prototype semiconductor-network modules were ready for approval by Litton's Data Systems Division.

The new shift-register circuits proved to meet the higher reliability standards imposed by Litton. In addition, construction was simplified and the number of soldered connections (potential trouble spots) were drastically reduced.

What are your circuitry needs: greater reliability? lower cost? lower power requirements? smaller size? lighter weight? SOLID CIRCUIT semiconductor networks can be your answer now. Call your TI sales engineer today, or write to Texas Instruments Incorporated, Department 470, for more information.

LEFT: New and old shift register cards are shown actual size for comparison. The top card employs 80 Texas Instruments semiconductor networks, while the bottom card is an earlier design using discrete components. Notice the simple, unsoldered arrangement of the top assembly. A much smaller printed circuit board could have been used if desired. RIGHT: A SOLID CIRCUIT semiconductor network is shown actual size.

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Mauler Engineering Mockup Shown

First photo of engineering mockup of Army's Mauler aircraft shows the solid rocket motor guided weapon in launcher about a trucked, self-propelled tank vehicle. Mockup is designed for use against isolated assets in forward zone or short range battlefield targets and targets. General Dynamics Pictures in press conference.

ball bearing splines. The bearing pins were bolted to keep driving around frequencies well above operating-speed frequencies. Each of the bearings is protected and has a design life of 1,000 hr.

Wing has a simple, non-actuating platform with a slight sweep on the leading edge. It is mounted on the fuselage with a negative dihedral angle. Full-span leading-edge flaps and full-span double-slotted trailing-edge flaps were fitted. Outboard segments of the leading-edge flaps operate independently in alternate. Dual synchronized actuators, with full strength in early use, raised the 60 angle. The angle can be varied from zero to 100 deg. from the horizontal; the latter deflection was planned to allow the XC-142A to hover in a tailwind.

Flight Controls

Primary flight controls are powered, with a dual hydraulic system as the power source. Cockpit control surfaces are fed through a conventional system, a linkage which determines the appropriate control surface deflection as a function of the wing tilt angle.

A low-frequency stabilization system—fed to pitch, yaw, roll and altitude data—is specified in IFR, stability characteristics and for stability in hovering and transition flight. It gives sta-

bility of pitch attitude and rate, yaw damping, roll attitude, and rate, and altitude damping.

Flight controls for normal flight are conventional, automatic, rather than the movable horizontal stabilizer perform their normal functions in VTOL flight, all control comes from differential collective pitch on the propellers, and is stabilized in both attitude and rate. Pitch in VTOL mode is handled in the tail rotor and also is stabilized in attitude and rate. Yaw control comes from the ailerons, operating in the propeller rotations; the control is rate stabilized. Roll in VTOL mode is handled in the tail rotor and also is stabilized in attitude and rate. Yaw control comes from the ailerons, operating in the propeller rotations; the control is rate stabilized.

Transition flight modes complex, but the mechanical designer is designed to cope with it. Roll control comes both from differential collective pitch on the propellers and deflection of the ailerons. Pitch control is provided both in the tail rotor and by the movable horizontal stabilizer. Yaw is handled by differential collective pitch on the propellers, and ailerons and rudder deflections.

Remember of the airplane version is almost nonexistent, modified only by an unusual speed datum, which marks some aspect of the VTOL or transition flight equipment.

There are three primary generator systems and one emergency generator system in the electrical system. One of the aircraft, with only two of the primary systems operating at any one time.

Electrical power operates engine, propeller, airframe, and mission loads. Dual, air-intake systems, provides for ground clearance and the in-flight engine power.

Takeoff power starts the engine, operates the controls, provides the basic energy for stabilization, utility and emergency systems. The utility system operates landing gear, brakes, doors, wing tilt angle mechanism, cargo doors, landing gear. There are four structural and engine and engine systems which were originally proposed when the design was a twin-engine transport. The emergency system operates the same with engine for structural turning and the landing gear and tail.

Structure of the XC-142A is completely conventional. Fuselage is the classical semi-monocoque type, built around the concept of providing maximum cargo space.

The wing has a continuous wing structure has surface on the leading, and is mounted to the fuselage at four points.

Fuel is located in two bladder cells on the upper fuselage. Forward cell feeds the aft cell, which has a pump leading to fuel booster pumps driven by the engine camshafting. Boost fuel capacity is up to 1,400 gal. Side fuel capacity is 1,000 gal. Fuel is carried in the fuselage cargo compartment.

Loading Method

Cargo or troop loading and unloading is primarily to be done through a ramp door at the rear. Over level of the cargo compartment is three feet above ground level. There is an alternate forward door on the fuselage port side.

Four basic mission have been defined for the operational life of the XC-142A.

• **New-Mission aerial mission.** This flight plan missions operations from a central takeoff at a gross weight of 34,500 lb, and turn in 5,000 lb payload at sea level, rising at 250 ft/s on two engines on a distance of 300 statute mi. It would make a vertical climb at a gross weight of 34,500 lb, for the trip back to the carrier. This mission base time is related to the mission payload. The XC-142A would land back on the carrier with 10% of its actual fuel remaining.

• **Army tactical transport mission.** This mission would enter a central takeoff at a gross weight of 37,400 lb, including a 1,000-lb payload. The air-

plane would enter at maximum altitude at a speed of 210 kt on two engines at a maximum gross weight of 37,400 lb. It would be able to land at 250 ft/s on two engines at a maximum altitude and land at the same time with 10% of actual fuel remaining.

• **Army tactical transport mission 2.** This flight would use the STOL capability of the XC-142A to increase both payload and range. It maintains operations between missions 300 statute mi. apart, with the XC-142A flying at maximum altitude and 210 kt on two engines, but starting at a gross weight of 44,000 lb with a payload of 14,000 lb. It would use VTOL operations at the mission start point and presumably similar weights to the basic flight.

• **Emergency mission.** The XC-142A would make a short takeoff from a perimeter base at a gross weight of 44,000 lb, carrying a payload of 14,000 lb. It would climb to 25,000 ft, then descend to 25,000 ft on two engines, cover a distance of 2,000 statute mi, and land vertically with 10% of the actual fuel remaining.

Conventional Criteria

Conventional performance criteria for the XC-142A show the maximum speed capability between 150 and 360 kt at sea level and between 350 and 370 kt at 35,000 ft altitude, depending on the aircraft weight and mission demand. Sea level rate of climb varies from about 5,100 fpm to 3,200 fpm, depending on the mission.

The permissible gun weight for VTOL operations is limited by the criterion that the thrust must equal 1.31 times the gross weight. Thrust is determined by the gross weight, the gross weight, which in turn is determined by the ambient temperature and whether or not water injection is used.

For a standard airfield base, the normal gross weight would be 40,000 lb for VTOL operations, not using water injection. With water for the engines, the gross weight can be increased to 42,500 lb.

On a sea-level transport case, the gross weight is restricted to 36,200 lb without water injection, and 37,400 lb with water injection.

Overall figures for the XC-142A design show that the anticipated performance is everywhere superior or exceeds the required values regarding, not set on the specifications. In two cases—STOL, maximum landing and takeoff distances—no quantitative figures were given; the performance was to be determined by the bidder and was to be consistent with the way the aircraft met other requirements.

First details of the XC-142A speci-

cations were revealed verbally by Colonel D. H. Smith, in a two-day session of the Air Force for research and development, at a conference on VTOL aircraft held in the National Academies and Space Administration at Langley Research Center on November, 1960.

Points were discussed that mission were designed to use the gross weight and the gross weight of the aircraft at the conclusion to present briefly the points as they were at that time (AIFW Nov 25, 1960, p. 31). Most of the requirements, which had been determined by a past service group of three teams, have remained essentially the same, the gross weight has been, which is standard for my design between proposal and contract award, and previously given between contract award and first flight.

Original aim was to finance a program of five aircraft for evaluation and test. If the item proved when they set out to prove, the aircraft could be moved into production with a minimum delay. If they didn't, the cost of the program was expected to be less than financing a second round of development VTOL aircraft.

Air Force and Army each transferred \$4 million in 1960 to the Navy, where the Navy was to be used for the program. The program was named pro-

gram mission. Navy was expected to give another \$1 million to give the program a firm foundation. Design proposals were submitted to Defense Dept. in April, 1961, with the hope that a contractor would be selected within a couple of months.

Three companies or teams submitted detailed proposals, with one of them financing the following of the development contract (AW May 1, 1961, p. 12).

Most of the company proposals also specified extension of the General Electric T40 propeller.

But the decision was delayed for several months, with Army and Navy split on the issue except to be chosen.

Navy wanted a suitable ducted-fan arrangement, and Army to use the T40 propeller arrangement. Air Force first offered with the Navy, and then switched to the Army (component USAF and Army then agreed on the best compromise design, the Navy yielded on all the program points. The Air Force then recommended the choice of the Hughes Helicopter team to build USAF was named program program arrangement, replacing the Navy's Westinghouse arrangement. The program, and all three services were to contribute \$2 million each by Fiscal 1961 and Fiscal 1962. Total program

Navy Missions for XC-142A

Planned Navy aircraft missions involve a variety of aircraft types which the Hughes Helicopter team believe could be replaced by the XC-142A.

The mission program on Navy operations consists of four missions: (1) Search and rescue (SAR), (2) Medical evacuation (MEDEVAC), (3) Search and rescue (SAR), (4) Search and rescue (SAR). The mission program on Navy operations consists of four missions: (1) Search and rescue (SAR), (2) Medical evacuation (MEDEVAC), (3) Search and rescue (SAR), (4) Search and rescue (SAR).

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NEARLY 300 HANDS-ON AUTOMATIC LANDINGS by DC-7 outland with British ILSU automatic landing system have helped convince Federal Aviation Agency and U.S. airlines that this is the best land-based approach to lower weather minimums. British return team welcome radio altimeter, fire-control computer and automatic throttle controls, with improved ILS localizer for lateral guidance.

FAA, ATA Pick British Landing System

By Philip J. Klaus

Washington-Performance of the British-developed ILSU automatic landing system resulted in a Federal Aviation Agency DC-7 during which 300 land-off landings in the U.S. has helped convince the FAA and U.S. airlines that this is the best available technical approach to safer low-weather landings and lower weather minimums.

FAA and the Air Transport Association agreed that the present ILS automatic approach system, provided with new systems when needed to improve performance to currently adopted International Civil Aviation Organization (ICAO) Category 2 standards, can provide adequate lateral guidance to reach down and vertical guidance to about 100 ft altitude. At that point the fire-control computer and radio altimeter can take over.

FAA and ATA believe that there is no substitute rule for competitive U.S. ground-based systems in civil operations. These include the Automatic Instrument Landing System, Flareless, Call-Back Regd and the Bell Aeromarine AN/AGN-5, as supposed version of which is to be used on Navy aircraft carriers.

British's original ILSU system was based on the use of a computerized radio altimeter to provide accurate lateral guidance during the final phases of the approach. Referred to by the DC-7, prior to its delivery to the FAA, using both radio altimeter and an ILS localizer equipped with the new directional in-

terns, showed that the two had complementary advantages.

Because of the difficulty and expense of installing radio altimeter at most airports, and because improved quality ILS will be required in all major international airports in accordance with ICAO standards, the British are expected to be ready to shoulder the leader's bill.

This suggests that there should be a broad base for general international use, an agreement in April when the International Air Transport Association met in London, Switzerland, to discuss air-traffic programs.

Really, half of the international land-off landings which the DC-7 has made in the U.S. since it was delivered this summer were conducted at the FAA's National Aviation Facilities Experimental Center (NAFEC) in Atlantic City wing and international test facilities.

The test have been made at more than a dozen different airports around the country. Only two of the nearly 300 automatic landings had to be aborted, one at Pittsburgh's Allegheny County Airport and one at Dulles, Mass., because of bad lands in the localizer beam.

Nearly conservative FAA and ATA representatives who have flown the DC-7 during these tests use the words "lateral" and "accuracy" to describe its performance. They are particularly impressed with the system's operational nature of the landings, without the last-minute adjustments of aircrew experience.

ment which characterizes flight tests on the competing ground-based U.S. systems.

In all fairness, it must be pointed out that the latter are experimental equipment designed only to permit evaluation of basic techniques rather than to demonstrate operational suitability. Nevertheless, the difference has been recognized.

Since describing aircrew pilots become silent supporters after the fourth or fifth automatic land-off landing, according to the FAA spokesman.

In demonstration for the FAA, the DC-7 made the first automatic land-off landing, according to a 90-degree angle to the runway during a night, without incident. Long lateral system, in maximum position along the runway was about 200 ft. In the second automatic landing, with a lateral offset of about 10 ft from runway centerline.

The 20-ft lateral offset includes a 10-ft, area which has varied during all of the U.S. tests, apparently the result of a slight change in approach angle as localizer receiver location. However, FAA has not attempted to take out the standard for the last landing, which can be expected without adjustment on a long period of usage.

The DC-7 is equipped with a modified version of the Sperry A-12 autopilot, an early prototype model that uses manual control. The use of the system in British design. The present computer and approach computer were built by South Atlantic, which also supplied

the automatic throttle control and fire-control system. The radio altimeter is a product of Standard Telephone & Cable, an affiliate of International Telephone & Telegraph Corp.

Although the U.S. Air Force first demonstrated the use of a fire-control computer and radio altimeter about 11 years ago, and several U.S. companies have built developmental models, none of these has demonstrated the consistent performance of the British unit, according to the FAA spokesman.

Tests Ended

FAA and USAF recently decided to terminate further tests of the North American, Autostar AN/AGN-144 fire-control computer on an F-102 because of unsatisfactory performance. Part of the trouble occurred from the fact that the autopilot in the airplane was built by Hughes Aircraft and the radio altimeter by Emerson, Jones, a subsidiary of LTV Industries, while Autostar supplied the fire-control computer. The trouble in system integration problems.

FAA has issued a contract to Southwestern Aircraft and Manufacturing Company for radio altimeter, originally developed for military use which will be tested in the DC-7 in place of the British equipment.

Consent of FAA plans for testing the all-weather landing system were decided recently by Robert J. Stank, deputy administrator for development, in response to 15 recommendations submitted by the ATA's Air Weather Operations Committee (AWOC). Admittedly difficult, were supplied by Air Force D. Wink, member of FAA's system design team, and the FAA's meeting in Atlantic City. Stank's report, in an official statement of FAA policy, showed the agency's views were somewhat close to those of the critics.

Following an investigation, the FAA agencies will be Stank, supplemented by details provided by Wink.

FAA intends to take the leadership in providing improved ICAO Category 2 U.S. facilities for about 15 major airports in the U.S. (Category 2 standard calls for performance which will permit operations to 100 ft. minimum height) first step in the upgrading will be the installation of radio altimeters, as well as to improve accuracy of the localizer beam. The agency will work hard to provide radio altimeter systems in the U.S. by 1964 budget, with the standard for the last landing during the following two years. Where required to provide good lateral glide slope beam profile, improved altimeter will be installed.

Performance of existing ILS localizer has been measured at 25 airports by Edgar Power Division of Bendix Corp., under FAA contract using photo-theodolite in the ground and aircrew



DC-7 COCKPIT shows instrumentation used in tests of British automatic landing system. System performance has been extremely impressive to U.S. engineers and airline pilots who have flown DC-7 at major airports around the country.

monitoring of localizer and glide slope signals, to determine which aspects require improvements to meet Category 2 standards. The report on this review is being readied for release shortly. •New field-of-view, designed to ensure the stability of the localizer beam at a point in the approach path between visible horizon and runway, is planned for Category 2 equipped airports. The field-of-view monitor will detect any deflection of the beam caused by surface traffic in the approach while the existing field-of-view monitor directly in front of the wingtip antenna will detect atmospheric effects of localizer malfunctions.

•Terminal area DME installation to provide pilot and aircrew with accurate information on aircraft distance from the runway during instrument approach under conditions TAA has two standards for DME equipment (radio) use to determine the best way to achieve improved DME accuracy needed for a terminal facility. The agency now is studying a modified TAA system, providing DME in terminal area, as an airport and is considering a similar installation on the West Coast to enable airports to use DME equipment in the U.S. by 1964.

Terminal DME information should be useful in automatic approaches to permit automatic change in approach path as the aircraft enters maximum descent rate with descent, providing more stable approach control.

Major point of divergence between FAA and ATA centers is on the question of the need for precision approach radar (PAR).

ATA says it uses no precision approach radar for PAR monitoring of ILS approach control more than Category 2 (100 ft., 1/4-mile) operations. It therefore recommends deletion of the requirement for PAR. This action was taken from the fact that existing PARs are not designed to track an aircraft below an altitude of about 200 ft., that they lack the accuracy needed to monitor an approach at low altitudes and that the funds required to modify or replace existing units with improved radar would better be spent elsewhere.

PAR Foes

Stank and the FAA believe that PAR, as an ILS antenna, contributes to the overall safety of the landing operation. The requirement for PAR monitoring of multiple approaches to a minimum of 200 and 1/4 mile is inherent. The knowledge that there are no consequences in present approach system cost and that that new specifications are being prepared. He noted that FAA has budgeted funds for additional PAR equipment in its five-year fiscal program.

FAA's major design team and the development division currently are working on a detailed air traffic system of what will be, acquired on the ground in the approach to the airport tower and in the ITR room. This is intended to guide aircraft and provide more information, approach and TAA's own expansion is moving toward the long-range goal of a weather operation, according to Albert Brown, head of the system design team.

FAA is convinced that the necessary



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telescopes are available as a result of several years of work at NAPEC, the British, and by the Air Force's Flight Control Laboratory. "Now it's largely a matter of deciding which pieces to mix and putting them together to form a well-integrated system," according to Brown.

An important constraint which FFA is imposing on the required airborne configuration is that it must be suitable for use in the existing fighter fleet, both technically and economically.

Flight Tests

Wreck, who is heading up the effort in the FFA system design team, says that "the time has come to clear the decks of more techniques which FFA has been exploring and to develop jointly coordinated development."

For example, by this spring Wreck hopes to have enough flight test information to decisively evaluate the basic Flockers or Regal techniques, or, he adds, to test for continued development as a possible in-flight replacement for the radar character in a sense of situational information during flight-out.

Recently, FFA evaluated both Flockers and Regal airborne units in a Boeing B-52 which is being used for side-by-side comparison tests at NAPEC.

The services do not believe that a version of the AN/GSN-5 type, which computes guidance commands on the ground and transmits these commands to the cockpit, is suitable as a primary civil approach aid, and FFA agrees. However, Bell has been told that the FFA is willing to consider the GSN-5 as an independent sensor system for RCAF Category 3 standards (aeronautical or for Category 2 if an independent sensor should prove to be necessary).

But unless the Air Force establishes an operational requirement for the AN/GSN-5 for tactical use, FFA is not expected to continue its work on the Bell system. Another candidate for the role of an independent sensor is the Bend Microsensor system (AW Sept. 14, p. 144).

Category 3

FAA hopes to have its Category 3 infrared optics configuration defined and system engineered by the end of 1963 and to have a prototype of this system ready for flight evaluation by the end of 1964. The package is not expected to include the details of an independent sensor system since agency thinking is fixed on this question and more work needs to be done before a decision is made.

Some observers express the hope that the FAA will outfit a turboprop transport with a duplicate of the British BLEU system now installed on the DC-7, to gain experience in the more difficult

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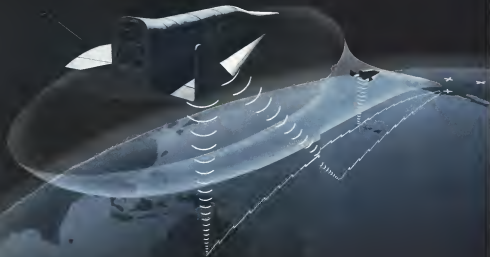
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Schroeder, Zvara and other Raytheon scientists have published many technical articles on recovery control requirements, problems and concepts. We have collected a number of these and bound them under a single cover. If you would like a copy of this comprehensive document on system requirements for manned space vehicle recovery, write: M. E. Carra, Dept. GM 13-48, Raytheon Co., Lexington 78, Massachusetts.



Raytheon's John Zvara (left) and R. L. Schroeder

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landing problems involved. Their point was that both the British and French governments, recognizing the essential importance of all-weather operations, are using indirect transport for their all-weather jobs, while the U.S. appears to be having trouble finding funds to follow suit.

During the recent ATA meeting in Atlanta City, eight airlines reported on their company programs to improve safety of bad-weather operations, and selected lower accidents.

While these individual programs undoubtedly in the airlines are in many ways similar, there also are a number of outstanding differences in emphasis.

Fat Air Program

For example, Fat American has put its entire emphasis on improving performance of its flight directors and pilot preferences in their use, with a similar effort on the autopilot approach coupled along several points.

Currently, about 70% of PAA's autopilot pilots have been qualified by the FAA for 200 ft., 3-mile minimum at selected airports using light direction.

Many of the remainder are ready to take their FAA qualification tests when schedules permit. These have been "no incidents or accidents" during the training or qualification, according to PAA's Ben McKel.

Coupler Approaches

Fat Air has applied for FAA approval for autopilot coupler approaches to 200 ft., 3-mile but has not yet received authorization. The airline has developed a modification for its Boeing 707 and Douglas DC-8 autopilots which provides split-on operation. Distorted control is provided to the autopilot, while the human pilot actually controls pitch and roll. This is expected to be useful where there are bends in the ILS glide slope which an autopilot



Shipboard Radar Duplexer

Experimental Yawceter type duplexers for Navy shipboard radar has successfully handled power levels greater than one megawatt, according to Electronic Communications, Inc., research division which developed the equipment. Work on prototype model is now in progress.



GAMMA RADIATION TESTS on Navy computer circuit boards are being conducted at the coast 80 irradiation facility at The University of Michigan. Shown above are circuit cards being inserted in the irradiation test cylinder. After the cards are in place, the coast 80 source is raised around the test cylinder. The waveform generator voltage probe leads are photographed during irradiation to measure both gamma dose rate and test patterns after effects.

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might try to follow but which a learner pilot can spare from experience.

On the other hand, American Aviation is placing its primary emphasis on the autopilot complex as the way to lower fuel-cost measures. A series of improvements are being made in the company's Kellogg-Pittman PB-280 autopilot to enhance its performance and reliability (AVF Nov. 27, 1961, p. 59).

Engineer intercept

For example, the aircraft now can intercept the leader at any angle above 45° it was limited to 17 deg. Autopilot descriptions to prevent over control in the glide slope beam sensors now is triggered when the aircraft passes over the outer marker instead of when it intercepts the glide slope beam.

To prevent the PB-280 from trying to follow small vagaries as heard in the beam as it scans the runway, the glide slope signal is disconnected from the pitch axis at the aircraft passes over the middle marker. For the remainder of the automatic approach the autopilot maintains the same pitch attitude it had when under glide slope control, using the verified given as a reference.

Such techniques are referred to as "glide slope extension." Lou Sengler uses a similar type of modification in its vibrating landing system for the Sud Caravelle (AVF Dec. 7, p. 47).

In theory, the use of only a pitch angle reference may allow the aircraft to overshoot or undershoot as desired



Laser Rangefinder

Low anglefinder, weighing less than 10 lb, including power supply, can measure range with error of about 5 ft. Developed by Raytheon's State Research (Gill) operation, new device has tendency to slip been known as target. Cheaper, plus production of the laser rangefinder.

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exchanger or other devices over temperature range of 25°C to 125°C . The Thermostat measures 2 in. dia. x 1 in. high, weighs 7 g. Device operates at voltages of 24 to 110 v.a.c. and can handle up to 60 watts. Manufacturer: Bulvac Wafac Co., Eastview Division, Woodside, N.Y.

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It's all new. The only gun available that incorporates all the features you've asked for in a spray gun.

Deep forged aluminum gun body... polished for extra protection. Ruggedly built to withstand abuse of production handling. Fluid passages are corrosion-resistant stainless steel... 4 Binks exclusive. Fluid threads also stainless steel. No seizing... no stripping. These features ensure long gun life.

Newly designed air passages... extra large... give you more effective air pressure at the nozzle... better atomization with less power.

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*with built-in steering
providing rotation
through 360° and
steering through ±60°*



Steering Motor



DOWTY EXPORTS LTD CHELTERHAM ENGLAND - DOWTY ROTOL INC ARLINGTON VIRGINIA USA

projected operating lifetime of 1,000 hr. Manufacture: Warrack Electronics Tubes, Inc., 175 West Dakota St., Des Plaines, Ill.

• Solid-state time delay, adjustable at field, with time delay values ranging from 0.1 sec. to less to 100 sec. Device is designed for use as printed circuit or module boards, consumes only 0.4 in.



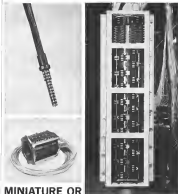
high, is available with tunnel wire leads at rigid pin connections on a 0.1 in. grid spacing. It is encapsulated, operates at voltages of 10 to 12 v. over temperature range of -65C to 125C. Wherton Eng. Div., Hewlett-Packard, Inc., 820 Manchester Rd., Wherton, Ill.

• Data storage-display system, Model 50411A, capable of generating 500,000 characters per second sans initial-state character generation with each connected from one to 25 individual line



segment. A Renard-dac memory is employed as storage element. Manufacturer: Labcon Electronics, Inc., 1075 Commonwealth Ave., Boston 15, Mass.

• FM telemetry transmitter, with carrier frequency stability quoted at 0.01%, has output power of 14 watts at the 215 mc. to 250 mc. band. The solid state transmitter's quoted stability, applies over temperature range of 0-55C, with deviation sensitivity of 180 kc/volt constant to within 1 db. Unit measures 3 x 5 x 3 in., weighs 26 oz. Manufacturer: Precision, Inc., Fort Worth 15, Texas.



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How Titanium lops pounds off VTOL Hummingbird

- Shakes off 600⁺ Heat
- Saves precious time

Like the hummingbird for which it was named, Lockheed Georgia's XV-4A (VTOL) is designed to take off straight up, loaf through down, hover in mid-air and streak forward at jet speed. Lockheed engineers say their job was made easier by the use of titanium on critical components.

Strength in a hot spot. Two titanium wing spars mounted forward and rear, give support to two jet thrust engines and a 25' 8" wing span. Exceptionally high strength-to-weight ratio wasn't the only reason for specifying titanium. Exhaust gases of 1300°F are drawn from the engines into a mixing chamber buried in the fuselage. Although a lot of this heat is contained, and some of it is dissipated, the outer portions of the wing spars are exposed to 500-600°F temperatures.

A high-strength steel alternate would have imposed a severe weight handicap

on a plane which had to shed every superfluous ounce to achieve optimum performance.

Get production time. The fact that titanium alloy Ti-6Al-4V could be used in its mild annealed condition (permissible strength of 130,150 ksi) saved precious time in a tight schedule. All alloys of steel would have had to be heat-treated to meet weight and strength requirements. This would have involved time-consuming machining and converting the inevitable warping consequent to processing. Mishandling the spars, a difficult operation in itself, could not have been done on fully-treated steel.

Titanium was selected for other vital components, including the main landing gear trunnion which carries the landing load into the plane's structure, dual shear on the fuselage in areas too hot for aluminum, and outer wing attack strips.

Here is where the Ti-6Al-4V titanium alloy has saved critical weight on the Hummingbird: (1) forward wing spar; (2) main landing gear trunnion, heat-treated to 150 ksi UTS; (3) outer wing attack brackets, heat-treated to 160 ksi UTS; (4) sparlet stiff wall; (5) aft wing spar.

Titanium's unique properties—light weight, great strength, resistance to heat and corrosion, its properties from minus 423°F to plus 1000°F, its weldability and versatility—are daily facts of life in military and industrial metallurgy. Titanium can solve your weight problem, too.



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BUSINESS FLYING



MODEL SHOWS GENERAL CONFIGURATION of proposed Macchi MB-339 jet liaison aircraft now under study. Draw shows general entry into previous civil-composition. Drawings due on the two jet executive aircraft in an other side of the landing.

Macchi Proposes Jet Liaison Plane

Varese, Italy—Aeronautica Macchi is proposing a single-engine executive aircraft to the Italian air force utilizing a large number of components now incorporated in its MB-133 trainer. Decision as to whether to go ahead with the project depends upon government development support and is expected by mid-February.

Macchi officials say the MB-339 liaison aircraft can be marketed at a base price of approximately \$500,000 plus another \$50,000 for full customization. Proposed payload is a 1,600-lb thrust version of the Turbomeca Astor.

If it does enter the already crowded executive jet field, Macchi probably will have to contend with a strong domestic competitor as well as other European and U.S. companies. Puggia, in partnership with Douglas Aircraft Co., now is developing, under government sponsorship, the 6 to 18 place PD-800. Proposed price of the PD-800 is about \$400,000.

As proposed by Macchi, the MB-339 would have a maximum speed of 516 mph at 15,700 ft. Cruise speed at 14,440 ft would be 415 mph. Maximum range with normal fuel reserves is pegged at 3,247 mi. Service ceiling is estimated at 41,000 ft.

The wing mounting, with its aerobically mounted on the aft fuselage section, would have a maximum gross weight of 18,114 lb, includes a 4,873-lb payload. Takeoff distance, over a 50 ft obstacle would be 2,716 ft, and landing distance would be 2,231 ft. Designed for certification under CAR3 specifications, the MB-339 would include a new fatigue design concept, meet with a volume of 77 cu ft. Cabin

would be pressurized to provide a cabin altitude of 5,000 ft at the 50,000-ft cruising altitude.

Wing span would be 35.44 ft, with a total area of 232 sq ft. Overall length of the Italian aircraft would be 35.77 ft.

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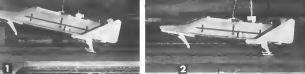


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1000 BRIDGE DRIVE/MENLO PARK, CALIFORNIA



Landing absorbers change to give great toepeak angles due to permanent elongation of model nose shock absorbers.

Tests Show Feasibility of All-Skid Landing Gear,

Feasibility of an X-20 Dyna-Soar did little to landing gear using retractable landing gear. Shock absorbers was demonstrated in 1/10-scale model tests at NASA Langley Research Center.

Vertical velocity free flight tests were an investigation of touchdown and landing (rollout) characteristics of the gear. Normal acceleration—initially, deceleration perpendicular to the model's longitudinal axis due to initial wing and nose gear touch down impact—were measured by shock gage accelerometers rigidly mounted on the model structure. Rollout behavior was recorded by motion picture cameras.

Test results included:

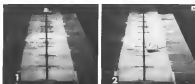
- Effect of touchdown landing speed—Main gear impact normal acceleration was largely insensitive to landing speed over a range of 4 to 12 g's. It was normal acceleration due to nose gear impact. Maximum values of these accelerations were about 1g and 1g, respectively.

- Effect of touchdown attitude—Nose and main gear impact normal accelerations were essentially constant for touchdowns pitch attitudes between 5 and 15 deg. Maximum values were the same as above. Touchdowns on a solid attitude without initial main gear contact contributed to shock buff.

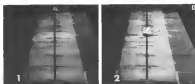
- Nose gear wingback—Increased wingback needed to reduce accelerations due to the change in gross inertial longitudinal moment. Normal accelerations at the nose gear were reduced from about 5 to 1g by increasing wingback angle from 5 to 15 deg.
- Nose gear landing—Along the nose gear shock absorber normal acceleration on impact because of a larger moment arm for the same angular acceleration of the model about the center of gravity.

- Yaw roll effect on directional stability—Directional stability was good for yaw and roll angles to 15 deg. In yawed landings, the vehicle entered a steady yawed into tail before yawed into gear and initial nose gear support due to inherent aerodynamic stability and high deflection forces on the main gear.

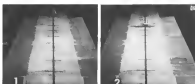
- Effect of varying rate of friction coefficient on skids—Directional stability was enhanced considerably low friction right by increasing the rate of the runway skid friction coefficient to that of the average skid of roadways yaw angles up to 15 deg.



Pitching ratio of 0.4 for test, left resulted in considerable porosity during landing, including backwash, pitch, dynamic, gear rise and clearance, and progressively depleted the



Pitching ratio of 0.6 increased directional stability, although lateral drift and oscillation in yaw for the present case included a gear touch speed of 130 ft/sec (30 mph) and an attitude

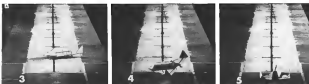


Pitching ratio of 1.0 caused virtually no change in yaw landing and negligible drift to the left of marked width of the runway. Best coefficient of friction ratio was found to be between 1.0 and



Yielding, wing alone could tolerate shockwaves equal to smooth. "Dribble" nose did absorb side forces during yawed landing.

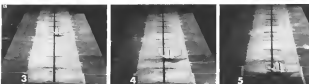
Yielding-Metal Shock Absorbers for Dyna-Soar



oscillation was, roll axis out wing and a complete ground loop over the end of the 180-ft. plywood runway. Model was constructed of balsa, integrated dynamic characteristics of the X-20.



were not completely eliminated. Wrappers of model was 1.64 ft., over all length was 3.22 ft. and weight was 3.5 lb. Initial landing conditions at 0 deg. pitch and 10 deg. left yaw.



the positive. A higher rate of 2.0 did not improve appreciably the directional stability, and in most cases the model stayed within the 4 ft. 3 ft. distance between rails on runway is about 5 ft.

MANAGEMENT

Lockheed Tops Defense Contractor List

Washington—Gains in relative position were registered by nine defense contractors in the group ranking from 10th to 30th of the top 100 companies who had prime contracts of \$10 million or more in fiscal 1962. The list now are the same, but the relative positions of the first four changed with Lockheed taking first place from General Dynamics Corp.

These 100 companies did 72.3% of all defense business in fiscal 1962. This figure has declined from 74.2% in fiscal 1958. Diversified emphasis on aircraft and increased emphasis on such items as selling stock and small Army equipment has allowed smaller firms to capture a greater share of the defense business.

The share of prime contracts distributed among the first five companies declined from 26.1% in fiscal 1958 to 22.3% in fiscal 1962. Likewise, the share of the first 25 companies declined from 57.5% to 53.2%, but the share of the companies ranking between 26 and 50 has risen from 9.1% to 12.6%.

Mergers affected four companies. Ford Motor Co., which merged with Philco, dropped from 43rd to 36th. Philco had ranked 51st in fiscal 1961. Long-Term Capital Corp. rose from 76th, while the predecessor Long-Term Capital Corp. in fiscal 1961 and Chrysler Corp. jumped from 14th to 10th while the Chrysler Corp. continued in 27th place, even though its total backlog increased from \$158.2 million to \$181.5 million.

Union Industries is in the 46th spot in fiscal 1962, having been out of the first 100 before its merger with Ingersoll Rand which was 56th in fiscal 1961. Last-September now ranks 56th, while the previous year last, Inc. ranked 60th and Singer Corp. was not in the top 100.

One of the largest drops was suffered by International Business Machines Corp., which dropped from 12th to 31st. Dollar volume dropped from \$170 million to \$155.5 million. Completion of the SAGE air defense system, accounted for most of the drop.

White Motor Co. jumped from 10th to 46th, representing a dollar increase from \$25.7 million to \$37.4 million.

Two electronics manufacturers dropped. Hughes Aircraft Co. went from 17th to 21st, declining in dollars from \$151.2 million to \$124.2 million. Hallenbeck Co. slipped from 41st to 59th, a drop from \$65.9 million to

\$25.7 million. The Hughes drop was due to phase out of some air-to-air missile contracts, while Hallenbeck completed contracts on electronic countermeasures.

Following are 100 companies and their subsidiaries listed according to net value of defense prime contract awards for fiscal 1962.

Rank	Company	1962 Sales	Fiscal 1962 Total
1	U. S. TOPIC	\$1,014.6	\$1,014.6
Total for subsidiaries and their subsidiaries			
2	LOCKHEED AIRCRAFT CO.	1,014.6	72.3
3	GENERAL DYNAMICS CORP.	1,014.6	47
4	BAIRD CORP.	1,014.6	4.6
5	UNITED AMERICAN AIRCRAFT CO.	1,014.6	4.8
6	GENERAL ELECTRIC CO.	1,014.6	3.2
7	GENERAL ELECTRIC CORP.	1,014.6	3.1
8	UNITED AIRCRAFT CORP.	1,014.6	2.4
9	UNITED AIRCRAFT CORP.	1,014.6	2.4
10	UNITED AIRCRAFT CORP.	1,014.6	2.4
11	UNITED AIRCRAFT CORP.	1,014.6	2.4
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28	UNITED AIRCRAFT CORP.	1,014.6	2.4
29	UNITED AIRCRAFT CORP.	1,014.6	2.4
30	UNITED AIRCRAFT CORP.	1,014.6	2.4

31	AMC CORP.	\$115.1	1.5
32	AMERICAN AIRCRAFT CORP.	216.9	1.2
33	AMERICAN AIRCRAFT CORP.	216.9	1.2
34	AMC CORP.	216.9	1.2
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97	AMC CORP.	216.9	1.2
98	AMC CORP.	216.9	1.2
99	AMC CORP.	216.9	1.2
100	AMC CORP.	216.9	1.2

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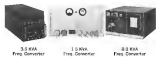
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67	AMERICAN CORP	40.4	0.0
68	AMERICAN S&S ASSOCIATES	27.0	0.0
69	AMERICAN LAMINATE PAPER INC	10.0	0.0
70	AMERICAN BROTHER CO	36.4	0.7
	AMERICAN BROTHER CO	0.0	0.0
	AMERICAN BROTHER CO	0.0	0.0
	AMERICAN BROTHER CO	0.0	0.0
	AMERICAN BROTHER CO	0.0	0.0
	Total	70.4	0.7
71	AMERICAN INTERNATIONAL CORP	56.0	0.0
72	AMERICAN WOODS CORP	28.4	0.0
	AMERICAN WOODS CORP	0.0	0.0
	Total	56.0	0.0
73	AMERICAN INTERNATIONAL CORP	23.0	0.0
74	AMERICAN CORP	44.7	0.1
75	AMERICAN & BARNES-SILAS	46.1	0.0
76	AMERICAN CORP	10.0	0.0
	AMERICAN CORP	0.0	0.0
	AMERICAN CORP	0.0	0.0
	AMERICAN CORP	0.0	0.0
	Total	46.1	0.0
77	AMERICAN INTERNATIONAL CORP	44.0	0.0
78	AMERICAN CORP	4.1	0.0
	AMERICAN CORP	26.1	0.0
	Total	40.0	0.0
79	AMERICAN INTERNATIONAL CORP	40.7	0.0
80	AMERICAN CORP	40.1	0.0
81	AMERICAN CORP	40.1	0.0
	AMERICAN CORP	0.0	0.0
	Total	40.1	0.0
82	AMERICAN CORP	40.1	0.0
	AMERICAN CORP	0.0	0.0
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83	AMERICAN CORP	40.1	0.0
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	Total	40.1	0.0
100	AMERICAN CORP	40.1	0.0
	AMERICAN CORP	0.0	0.0
	Total	40.1	0.0



Saturn Assembled

Complete Set: C1 Block 2 volume is available at Ilwaco, Ark. price to dynamic links for vibration and bending studies. Volume counts of S1, S-6 (sharp) and S-6 (smooth) are shown.

	Amco Corp.	16.0	0.4
	Chubb Corp.	16.0	0.4
	Chubb Indemnity Corp.	16.0	0.4
	Total	16.0	0.4
41	JOHN DEERE	15.0	0.0
	Deere & Co.	15.0	0.0
	Deere Financial Corp.	15.0	0.0
	Total	15.0	0.0
42	JOHN DEERE, INC.	15.0	0.0
	John Deere Inc.	15.0	0.0
	Total	15.0	0.0
43	JOHN DEERE, INC.	15.0	0.0
	John Deere Inc.	15.0	0.0
	Total	15.0	0.0
44	JOHN DEERE, INC.	15.0	0.0
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45	JOHN DEERE, INC.	15.0	0.0
	John Deere Inc.	15.0	0.0
	Total	15.0	0.0
46	JOHN DEERE, INC.	15.0	0.0
	John Deere Inc.	15.0	0.0
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47	JOHN DEERE, INC.	15.0	0.0
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	John Deere Inc.	15.0	0.0
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	Total	15.0	0.0
71	JOHN DEERE, INC.	15.0	0.0
	John Deere Inc.	15.0	0.0
	Total	15.0	0.0
72	JOHN DEERE, INC.	15.0	0.0

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1. Hdp logo
2. high density polyethylene
3. inner tube
4. braided reinforcement
5. end fitting

30 ft. lengths can be fabricated! Polyethylene is easy to clean and is highly resistant to the effects of stress.

1. Braided and spiral plies are of stainless steel for maximum corrosion resistance.

2. Negotiates curve to withstand rough handling and exposure.

3. Anchor exclusive stress steel, double stress braided construction.

4. braided and spiral plies are of stainless steel for maximum corrosion resistance.

5. The Anchor Hdp Hose Assemblies fully conform to MIL-H-81964 (USAF) specifications. Available in the 4, -10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1200, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 6000, 7000, 8000, 9000, 10000, 12000, 15000, 20000, 25000, 30000, 35000, 40000, 45000, 50000, 60000, 70000, 80000, 90000, 100000, 120000, 150000, 200000, 250000, 300000, 350000, 400000, 450000, 500000, 600000, 700000, 800000, 900000, 1000000, 1200000, 1500000, 2000000, 2500000, 3000000, 3500000, 4000000, 4500000, 5000000, 6000000, 7000000, 8000000, 9000000, 10000000, 12000000, 15000000, 20000000, 25000000, 30000000, 35000000, 40000000, 45000000, 50000000, 60000000, 70000000, 80000000, 90000000, 100000000, 120000000, 150000000, 200000000, 250000000, 300000000, 350000000, 400000000, 450000000, 500000000, 600000000, 700000000, 800000000, 900000000, 1000000000, 1200000000, 1500000000, 2000000000, 2500000000, 3000000000, 3500000000, 4000000000, 4500000000, 5000000000, 6000000000, 7000000000, 8000000000, 9000000000, 10000000000, 12000000000, 15000000000, 20000000000, 25000000000, 30000000000, 35000000000, 40000000000, 45000000000, 50000000000, 60000000000, 70000000000, 80000000000, 90000000000, 100000000000, 120000000000, 150000000000, 200000000000, 250000000000, 300000000000, 350000000000, 400000000000, 450000000000, 500000000000, 600000000000, 700000000000, 800000000000, 900000000000, 1000000000000, 1200000000000, 1500000000000, 2000000000000, 2500000000000, 3000000000000, 3500000000000, 4000000000000, 4500000000000, 5000000000000, 6000000000000, 7000000000000, 8000000000000, 9000000000000, 10000000000000, 12000000000000, 15000000000000, 20000000000000, 25000000000000, 30000000000000, 35000000000000, 40000000000000, 45000000000000, 50000000000000, 60000000000000, 70000000000000, 80000000000000, 90000000000000, 100000000000000, 120000000000000, 150000000000000, 200000000000000, 250000000000000, 300000000000000, 350000000000000, 400000000000000, 450000000000000, 500000000000000, 600000000000000, 700000000000000, 800000000000000, 900000000000000, 1000000000000000, 1200000000000000, 1500000000000000, 2000000000000000, 2500000000000000, 3000000000000000, 3500000000000000, 4000000000000000, 4500000000000000, 5000000000000000, 6000000000000000, 7000000000000000, 8000000000000000, 9000000000000000, 10000000000000000, 12000000000000000, 15000000000000000, 20000000000000000, 25000000000000000, 30000000000000000, 35000000000000000, 40000000000000000, 45000000000000000, 50000000000000000, 60000000000000000, 70000000000000000, 80000000000000000, 90000000000000000, 100000000000000000, 120000000000000000, 150000000000000000, 200000000000000000, 250000000000000000, 300000000000000000, 350000000000000000, 400000000000000000, 450000000000000000, 500000000000000000, 600000000000000000, 700000000000000000, 800000000000000000, 900000000000000000, 1000000000000000000, 1200000000000000000, 1500000000000000000, 2000000000000000000, 2500000000000000000, 3000000000000000000, 3500000000000000000, 4000000000000000000, 4500000000000000000, 5000000000000000000, 6000000000000000000, 7000000000000000000, 8000000000000000000, 9000000000000000000, 10000000000000000000, 12000000000000000000, 15000000000000000000, 20000000000000000000, 25000000000000000000, 30000000000000000000, 35000000000000000000, 40000000000000000000, 45000000000000000000, 50000000000000000000, 60000000000000000000, 70000000000000000000, 80000000000000000000, 90000000000000000000, 100000000000000000000, 120000000000000000000, 150000000000000000000, 200000000000000000000, 250000000000000000000, 300000000000000000000, 350000000000000000000, 4000000



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the 13 to the 5 o'clock position¹ and measured 3 inch in width. The inner edge of this deposit was common with the inner circumference of the landing, above the outer edge was, in places, slightly beyond the landing's outer circumference, however, a slight surface of two inches of the bolt's head was visible around its outer periphery at the deposit.

The smaller deposit occurred on an 60 deg between the 7 and 9 o'clock positions and, like the large deposit, the outer edge was common with the landing's inner circumference and about 3 inch wide.

There were more small marks across the face of both deposits, but neither had more of any compressive loads sufficient to flatten their top surfaces. These patterns of the landing check had no bearing upon landing clevis² fillet of grooves of the same consistency.

After drawing the faces of the landing, it was examined for scratches, bending and distortion. No elongation of the landing hole could be found. On the bearing's shoulder face there was a mark on the outer circumference at the 5 o'clock position measuring 0.010 x 0.061 in. and estimated to be 1/32 in. deep. Also present were light circumferential scratching and pitting. These light longitudinal scratches could be seen in the face of the bearing, but were not discernible when it was checked. At the outermost base of the bearing surface scratches could be seen as the bearing. The edge of these scratches was consistent with the general direction of the bearing and the approximate diameter of an AN380-118 washer. It was noted, however, that the edges of the groove deposits had scalloped patterns of the scratched area. Other than light circumferential scratches, the face of the bearing showed no impact marks, bending, or distortion.

On the outermost face of the arm assembly P/N 291505L it was seen the edge there was a deep groove wide in the deep corner of the clevis of the P/N 290796 link assembly. The face of the clevis was generally smooth and the maximum depth was 0.011 inch with diffuse chatter marks across the group face. Along one side of the triangle the edges were scalloped in shape, showing some of the mechanical ridges of chatter. The hole hole at the open end of the link could not line up with the arm assembly bearing when the clevis was aligned with one of the attachment points.

The set of the moving bolt is actually centered against the outermost face of right arm assembly P/N 291505R. There was no deposit of grease on the outermost face of the bearing of the right arm. This was the most of the oil seen on the lower splines of grease and did not as appeared on the left arm. Some grease was present but only in a film. The colored face of the

the check position were referenced by placing an imaginary line through the centers of the triangles (see bolt hole) in the actuator and the bolt hole in the direction of 11 o'clock. Therefore, each reference were made to the bolt hole being viewed at the time. Subsequent cases on the bearings were observed by viewing imaginary lines through their centers perpendicular to the reference line of the point and with the 13 o'clock and 9 o'clock marks on present photographs.

bearing was measured except for slight compressive scratches. The surface of a washer could be seen on the face of the bearing, but sufficient pressure had not been applied to remove the zinc chromate. The oil-covered surface of the bearing's bore showed human corrosion from the outer bushings and contained some organic staining. There were several discoloration marks on the bearing's shoulder between 9 through 3 o'clock. At several places near the 13 o'clock position these markings were polished and flattened. The colored face of the bearing was clean and a considerable amount of the link bearing was visible. There was a thin grey mark at the bolt's outer circumference at 9 o'clock, 0.05

in wide by 0.10 in. long, parallel to the axis indicated. The outer circumference of the bearing's shoulder face at the 13 o'clock position there was a curved mark 0.015 in. long by 0.015 in. wide.

When viewed under magnification, no other landing could be seen corresponding within the flat area. The curvature of these marks, opposite in size to the circumference of the bearing, marks marked that of the cracks and of the P/N 190796 link, were by. The face of metal showed that both bearings had been forward in a direction very from the bearing and in. No elongation of the landing hole could be found.

The bolt hole of link assembly P/N 290790 which is the bearing inner race,

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fastening
for
industry



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A collage image. The left side shows a close-up of a dark military pilot's helmet with a silver eagle emblem on the front and a white lightning bolt design on the chin strap. The right side shows a retail store interior with two men standing behind a counter, looking at products on shelves. The image is split vertically down the middle.

BCR

Systems Analysts & Preliminary Design Engineers for Advanced Space Guidance & Control Systems

Rapid expansion of space capabilities, projects and studies at the HUGHES Aerospace Division in Southern California, has created unusual opportunities for several qualified Engineers, Physicists and Mathematicians for Advanced Space Systems assignments. Significant openings are available in the following areas:

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- TRANSLUNAR GUIDANCE & NAVIGATION
- EARTH ORBIT NAVIGATION
- RENDEZVOUS & RE-ENTRY GUIDANCE

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To study and develop guidance and navigation equations and techniques, make feasibility and error analysis, establish safety-

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which is negligible. An increase above this speed would be necessary to overcome the wind. It is important to note that the speed of the aircraft will start to increase only after the aircraft has started to move up. The speed of the aircraft will start to increase only after the aircraft has started to move up. The speed of the aircraft will start to increase only after the aircraft has started to move up.

No Pilot Input

Further advances in the design of the aircraft will be in the area of the control system. The control system will be designed to be able to fly the aircraft without the need for a pilot. The control system will be designed to be able to fly the aircraft without the need for a pilot. The control system will be designed to be able to fly the aircraft without the need for a pilot.

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INSTANT LAUNCH

Will space vehicles of the future be launched on a ready-raise basis? "Yes," says Robert A. Bailey, chief spacecraft engineer of Lockheed-California.

"Refinement of current launch procedures is inevitable in the years ahead if we are to achieve greater efficiency for America's space effort. New techniques in spacecraft launching are essential if we are to rendezvous with manned space-based vehicles."

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comparing vibrations caused some structural damage to the wings and the fuselage in the aft portion of the fuselage. Further proof that structural still was under structural failure is found in the records of RVN structural integrity tests. During one flight the aircraft was and certainly got into an accelerated stall. In spite of the fact that the aircraft was in a complete situation of the right stability was not a problem. The aircraft was loaded with a 100,000 lb. load of the fuel at which the test was held at 10,000 ft.

Conclusions

The Board has attempted to state in this report how the physical conditions of the aircraft were found to be the cause of the structural failure. It is the opinion of the Board that the aircraft was in a complete situation of the right stability was not a problem. The aircraft was loaded with a 100,000 lb. load of the fuel at which the test was held at 10,000 ft.

The Board concludes from the evidence at hand that during its flight the aircraft was in a complete situation of the right stability was not a problem. The aircraft was loaded with a 100,000 lb. load of the fuel at which the test was held at 10,000 ft.

The manner in which the test was held at 10,000 ft. was not a problem. The aircraft was loaded with a 100,000 lb. load of the fuel at which the test was held at 10,000 ft.

On Nov. 22, 1965, the Board was notified by the Air Force that the aircraft was in a complete situation of the right stability was not a problem. The aircraft was loaded with a 100,000 lb. load of the fuel at which the test was held at 10,000 ft.

With such a management, all the aircraft was in a complete situation of the right stability was not a problem.

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"Just" the sort of aircraft research that will be extremely needed for troop transport, surveillance, logistics, and special mission—many of which will have a high future in the commercial marketplace as well. Here are some of the projects in the works at TRECOM today:

- A flexible wing vehicle capable of being packed into a form which would allow it to be used by a variety of transport means for transport, directed attack.
- The X-44 VTOL aircraft, which is the first step in the development of a new type of aircraft which is the first step in the development of a new type of aircraft.
- A new Hot Cycle Piston Jet Engine System, which is a revolutionary technique for increasing helicopter speed and payload.
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This VTOL aircraft embodies a "lift lift" principle which will be first tested in 1965

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be released prior to the scheduled destination and would thus allow the complete, self-contained, self-contained system of pilot-applied control forces.

On March 6, 1961, the Administrator advised the Board that his Agency was keeping the Cockburn Flight Manual amended to include, provision for jettison of the device used with an uncontrolled descent.

The Administrator further advised that "in view of the cockpit service history advanced by the aircraft service companies in 1946, we believe there is sufficient justification to require design changes to accomplish zero loss object."

Although many of the cockpit board provide a possible means of a warning unit that appears helpful to assure that a pilot will not do and cannot conceivably the flight manual instructions which contained acceptable with a cockpit, such as the spring monitor indicator, seemed to be pointing in the correct field. The Board therefore recommended on Sept. 16, 1961, that further consideration be given to such action of the cockpit system.

Predictive Cases

The Board discussed the probable cause of the accident was the loss of an AN-121 model steel ball from the predictive linkage of the cockpit board system, resulting in loss of control of the aircraft.

By The Civil Aeronautics Board
Walter E. Ford, Chairman Robert T.

Murphy, Vice Chairman, Glen Gerner, Member, C. Joseph Maestri, Member, William G. Leland, Member.

Investigation and Hearing

The Civil Aeronautics Board was notified of the accident on Sept. 3, 1961. An investigation was immediately initiated in accordance with the provisions of Title 48 of the Federal Aviation Act of 1958. A public hearing was held by the Civil Aeronautics Board and held at the Charles Continental House, Virginia Hotel, Chicago 18, on Sept. 27, 1961.

Flight Personnel

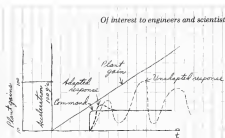
Capt. James M. Sanders, age 40, was employed by Trans World Airlines (TWA) and was promoted to captain June 15, 1954. He had a total flight time of 17,111 hr., of which 12,057 was as Commander-in-Chief. The total instrument time was 12,175 hr. Captain Sanders held a FAA certificate and a certificate of airworthiness (transport rating No. 271741) issued June 30, 1956 on Douglas DC-3, Votair 241-404 and Lockheed Constellation. The date of his last physical check was June 28, 1961 with no waivers. He had a last period of 19 hours prior to subject flight. The last physical check was June 17, 1961, on a Lockheed Constellation and his last flight check was on May 29, 1961. The date of his last emergency equipment review was June 14, 1961.

First Officer Dick Tarnoff, age 31, was employed by Trans World Airlines Dec. 5,

1951. The total flight time was 5,544 hr. 14, of which 1,573 was as Commander-in-Chief. Tarnoff had a total instrument time of 542 hr. His last period prior to subject flight was 19 hr. He held a certificate of airworthiness (transport rating No. 111709) issued May 16, 1956. The date of his last FAA certificate physical check was Oct. 21, 1961, with no waivers. The last period prior to subject flight was 39 hr. The last physical check was May 11, 1961, on Lockheed Constellation equipment. The date of his last emergency equipment review was May 17, 1961.

Flight Engineer James C. Newlin, age 18, was employed by TWA May 21, 1959. He was promoted to flight engineer Nov. 15, 1959. The total flight time was 5,035 hr. 14, of which 1,573 was as Commander-in-Chief. Newlin held a FAA certificate No. 111644 issued May 1, 1959, and FAA flight engineer certificate No. 125275 issued Apr. 9, 1959. The date of his last physical examination was Dec. 46, 1960 with no Class II status. His last physical check dated May 29, 1961, was on a Lockheed Constellation flight deck. Flight Engineer Newlin's last flight check was Apr. 9, 1961 and the date of his last check on Constellation equipment was Apr. 27, 1961. The last emergency equipment review was May 29, 1961.

The two checkrides were Barbara Sue Foster and Norman G. Pedger. Both had complied with all company requirements with respect to training.



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Work will be in RMD applications engineering of semiconducting devices (logic, analog, nonlinear, switching circuits, etc.); **SERVOHYDRAULICS** (fluid engineering with aircraft control system experience for aircraft control test programs). These tasks demand the following: development and test of hydro-mechanical type servo valves for control surface hydraulic actuators; bench test of control surface actuators to determine spring rate, frequency response and dynamic characteristics and subsystem test of control surface actuators and associated linkage to determine dynamic performance characteristics of time constants, damping ratios and stability margins. ■ If you're looking for a company where your opinion counts in creative problem-solving, send your complete resume to: Professional Placement Dept. LTV, P.O. Box 2002, Dallas 75220, Texas.

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WHO'S WHERE

(Continued from page 23)

Honors and Elections

Dr. Gooking F. Chen, Professor of Physics of the Chemistry of California Radiation Laboratory at Berkeley, has been named recipient of the 1962 American Physical Society Prize, sponsored by Hughes Aircraft Co., for his continued efforts to understand cosmic neutron interactions.

Dr. Rocco N. Willis, chief research of Vehicle Technology, has been awarded the Founders' Medal of the Air League at Coast Branch. Dr. Willis pioneered the smaller aircraft wing wing.

T. Norman Salada, International Control Electric Co., has been elected 1961 chair man of the Aerospace Industries Ass'n's Export Committee.

William J. Kieffer, still vice president of Bellco Electronics Co., has been elected president of the Society of Automotive Engineers for 1962.

William T. Taylor, board chairman of ACF Industries, has been named president of the Defense Orientation Center over Ann, Pa. 1965.

James Louis Ar. Tim Co., has been elected president of the Space Air Test Conference for 1962. H. C. Conant, Bellco, Inc., has elected for vice president, and Charles D. Bell, Jr., General Electric, has been elected.

Changes

C. B. Appleman, manager, Civil Space Division of General Electric Co.'s Defense Program Division, will head quarters in Houston, Tex.

Robert E. Enry, chief, Men Systems Department Division, Office of Research and Development, National Aeronautics and Space Administration's Office of Advanced Research and Technology.

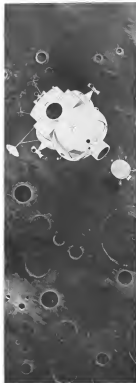
William E. Wells, general manager, West Coast Operations (China Mine, Calif.) Site Development Division of Pacific Electric Corp. William F. Claver Jr., manager of technical services, Bellco, Inc., Men, Tex.

Robert L. Lantz, manager of manufacturing and engineering, North Products, Inc. (Squadron Co.), a subsidiary of North American Aviation. Also Jack M. Tinsley, assistant product manager for North.

Dr. Donald Wahl, manager of research and engineering-center projects North, General Dynamics (Birmingham, Ala. Dept. Co.), and A. H. Wolcott, manager of research and engineering-center projects North.

Dr. W. H. E. Lark, assistant chief engineer, Aerospace Research Division of Texaco's Bell Laboratories Co., Buffalo, N.Y. Research Foundation, senior research in research Lab Support Department, Westinghouse Corp.'s Systems Division, Boston, Mass.

Col. Robert H. Manno (USAF), at present, research manager and assistant head, Planning Research Corp., Los Angeles. Dr. Ronald G. Rao, head, Material Science Division, Department of Technical Information, Armed Services Technical Development Agency (ASTIA), Arlington, Va.



LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

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Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

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OGO's purpose is to gather and transmit data on
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It will be launched into an extensive orbit by an Atlas-
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Its assignment will be to send back information about
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- ☐ Senior Electronic Engineers to analyze and record manned communication programs.
- ☐ Flight Systems Engineers, experienced in the use of analog and digital computers, to solve flight operations and other research and development problems.
- ☐ Aerospace Engineers, experienced with flight simulators in the training of test pilots and flight personnel. Past experience is not desirable.

Send a complete resume to: Mr. J.
O'Sullivan, Dept. 240, NASA Manned
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I cannot take away the money, the right of 500 jet passengers boarding Cleveland buses for a 1^{1/2} hr. ride, Salt Lake San Francisco, a few nights ago during San Francisco's big sale. Surely on this day of Made 1 jet managers, orbital flights and all the fantastic post of jets of just around the corner, no one is thinking on best horse.

In 1990-1997, we completed for Capt. R. V. Perry at G-16, when we routinely made broad-acre area landings on a Boeing 747-200 using the three-pointed ILR system. Of course, G-16 had no infinitely long (5,000 ft) runway. Even then our runways were 300 ft, and now almost 17 years later, with our frequency they spilled over a sixth runway we're still pushing our luck with 200 ft.

We ought to quit looking up to the sky, above and occasionally behind, at the good being.

Leo Kanner
Capitol
United Air Lines
San Francisco, Calif.

Being an avid student of foreign power and national defense policy, I must say that Defense Secretary Robert S. McNamara is playing a very strange and increasingly unwise

He has given official answers to the Director of Controlled Response with its Casualties of Counter-force Members and Co-ordinated Options. This paper is a basic attempt to measure the degree of authorisation from the civilian population of our state by compelling the South, through our own military apparatus, to follow similar steps. It is, in my opinion, a thoughtful example of much needed, though logical thinking demanded by asking our complex defence authorities.

"But the reality, in effect, means that we still have to mouth off and support the Soviets in every field of military organization, and this is where Mr. McNamara's attitude does not continue to help policy. Take the case of the RS-70 missile—remember that it was developed by the Soviet Union—and that place at a "satellite" version of the future's armament." As far as myself I must also wish the Air Force Chief of Staff Gen. Curtis E. LeMay and Rep. Carl Vinson, Chairman of the House Armed Services Committee, who saw the production of the RS-70 as a real step forward in our defense program. In fact, without military operational capability, I would place the RS-70 as the greatest and most critical need improvement in the Air Force's inventory. I am prepared to defend my stand in terms of the Air Force's own strategic doctrine.

Fred M. Allen

Aspen Work continues the system of its readers on the issues raised in its magazine's editorial columns. Address letters to the Editor, Aspen Work, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a general identification. We will not print anonymous letters, but names of writers will be available on request.

[illegible]

Unfortunately, we will have numerous bomb attacks on continuous airborne alert to deal with such situations. In the case of a Soviet tank attack our fighters will have to be used only in a second wave. Our sustained bombers will still make the first blow, and replace us only when this can be realized in time of a late attack, but it is painfully evident that the Soviet defense against our B-52s and B-4s is one of its top priorities. An operational fleet of B-51s would put a tremendous military and economic strain on Russia and thus is one purpose of the McNamara doctrine.

Secondly, one must note, in the case of my knowledge, are simply not accurate enough to be used solely and exclusively against railway targets. The 1941 first series of the *Handbook of the German Air Force* (1941) lists some, classified up to a certain level, public buildings (ICBMs) of the SA. On giving a general view of a 20 magazine workshop (the latter paid a well known 40 magazines), this accuracy is ineffective against which the railway targets are not. The accuracy of the accuracy of manual handling even with long range as to railway targets is to some extent. When mobile targets are to be tracked through ICBMs, or transferred, another because serious task, around the railway with their great ability in locomotives, aircraft, and other targets.

Mr. McNamara does not seem to realize the necessity of the task he has chosen to undertake. The Russians already have a superior intercontinental ballistic missile of our old B-36. A nuclear-powered version of this same plane, the *Banshee*, is reportedly under development to counter our Polaris subs. I think, believe that if we can

orts to make an efficient quantitative strategy, we must first recognize the full scope of the challenge and not hesitate to produce the means to achieve the stated end.

J. Mennert, Industrie-
Universitt Wien

Your article (VO 126, 3, p. 117) on test-tube babies and its parallel, which have no points in common. The *Rangstroms* Brand is not just "feminicide," but, as certainly infelicitous, according to the decisions recorded in Judge Werber, and Madsen.

The Reproduction Ratio is an important concept from that post. "Sellers fear of increasing manufacturing making huge profit is an over-valued position. Money is not enhanced that concept. For a comparison of profit margin let's take industries such as Electronic Structural Oil and, as U.S. Steel Corp. is the oil and steel in distance will find not profits as between Africa and twenty per cent of poor delinquents."

The defense contribution in this nation makes less than five per cent net profit on the most delinquent.

Let's acknowledge the major competitive advantage of being that way is a pricing issue, not a product issue. (1) It is very obvious, even blended with the electrical lines noted, and (2) whether it is real or not, the contract is signed with no government share clause. But if it is really money-saving or technological development while working on a government contract, it must make the information available to any other government contractor who might wish to obtain it.

The Joint Whistlers' subcommittee, engineering and manufacturing know-how are as strong as, at a two dollar bill is soon with the one did not have to pay the Bureau of Internal Revenue. The Bureau has been and is following the best dollar value per dollar spent with this comparison. It is more than a dollar that I personally find of I ranked for the Bureau of Internal Revenue in 1996 and into preliminary design engineer to grant, everyone was educated in ways and means of doing things in the given and the commercial systems the best engineered, most efficient manufacturing and resource superior products associated

A suggestion by Martin-Oskander's value analysis team "was not to subject to random use or before a product is designed for production. The university just said as long they don't have made what due mostly to a predictable but known as a learning or experience curve."

Since Robert S. McManis is already spending my daughter's tax money on my last defense work, I can only wish his success in his efforts to scrapbook the economy to his presumed President Kennedy.

W. H. McEwen
Hydrometallurgy, Canada



TABLE 1
A Bell Digital Voice

accelerometer) and velocity data for both the successful Mariner III velocity factor in the mid-course correction.

Bell has built many important space programs have already been performed. The heart of the Bell D three mission and

Ball can provide control as well as

The digital velocity space building block. The cutoff velocity

A Bell Digital Velocity Meter (with an Bell Model III-B

accelerometer) integrated accelerometers to provide critical velocity data for both Agena rocket engine cutoffs in the successful Mariner flight. A second type of Bell-built digital velocity meter in the Vega-bound probe functioned in the mid-course correction.

Bell has built more than 100 velocity meters for use in important space programs. More than 25 of these velocity meters have already been utilized in space flights. Every one has performed flawlessly. Over 1,000 Bell accelerometers, the heart of the Bell Digital Velocity Meters, have demonstrated their precision and reliability in actual service.

Bell can provide velocity meters for rocket engine control as well as for use on aerial platforms. The velocity meters were originally developed for use as part of the Bell family of Eperans (High PERFORMANCE Navigation Systems) guidance and attitude reference systems.

The digital velocity meters used in the Mariner are considered space building blocks because of their accuracy and versatility. The cutoff velocity can be inserted in the digital integrator by

Self-velocity Meter No. 11 on the Marine Probe analysed the mid course before the engine failed.

Shell Velocity Motor No. 1 controlled the Marine Age's Diesel Engine until twice. And for the pasting oil injection and then for the Motor Exhaust injection.

VELOCITY CONTROL

BELL VELOCITY METERS CONTROL MARINER, RANGER...

telemetry if a reprogramming in orbit is desired. The accumulated velocity can be telemetered from the vehicle upon command. More than one cutoff velocity can be loaded prior to launch and each utilized during different engine burns. These and other features can be provided utilizing proven circuitry and techniques.

Advanced digital velocity meters are currently being laboratory proven. Velocity meters can be furnished weighing less than 5 pounds including the digital integrator and comparator. These units will withstand even the most rigorous environmental conditions. Inquiries are invited.

The Bull Agency Rucker Kinsler, which placed both Karger and Marder in polling series and thus revealed them as their competitors to the Moon and Nixon respectively. The 1960s proved third Agency has had more than 40 years in space—his past more successful, perhaps in space than any other space.



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HERE

How the Phantom Affects Multiple-Mission Economy

Defense planners, seeking to increase the combat capability of fighter aircraft squadrons, quickly recognize the economic advantages of a single aircraft capable of performing a variety of combat missions.

The McDonnell Phantom II has demonstrated its adaptability to five major combat missions:

Air Defense, Air Superiority, Long Range Attack, Tactical Ground Support and Tactical Reconnaissance. Here's how:

World Record Performance: The Phantom II has set 15 world speed and altitude records including all eight time-to-climb marks. It has achieved a top speed of over 1650 mph, climbed to over 100,000 feet.

World Wide Range: Operating from carriers or existing suitable friendly land bases, the Phantom II can deliver ground strike weapons over 92% of the earth's surface. As an air superiority fighter, its combat range extends over 96% of the earth's surface.

Multiple-Mission Armament: The Phantom II can deliver Sparrow III, Sidewinder, Bullpup missiles, 2.75 inch Mighty Mouse rockets, conventional bombs, napalm, or nuclear stores.

Multiple-Service Acceptance: The Phantom II is now fulfilling air defense, air superiority and long range attack missions for the United States Navy and Marines. The Phantom II has also been selected by the Air Force to augment the tactical strike and reconnaissance capability of that service.

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Phantom II Fighter, Attack and Reconnaissance Aircraft •
Mercury, Gemini, Atlas and Aeroballistic Spacecraft • Telos and Typhon Missile Airframes and Engines •
Electronic Systems and Equipment • Automation

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